



INSIGHTSIAS

SIMPLIFYING IAS EXAM PREPARATION

INSTA PT 2020

EXCLUSIVE



INSIGHTSIAS

SIMPLIFYING IAS EXAM PREPARATION

SCIENCE AND TECHNOLOGY

May 2019 – February 2020

Table of Contents

| | |
|---|-----------|
| Defence Technology..... | 5 |
| 1. QUICK REACTION SURFACE-TO-AIR MISSILES (QRSAM)..... | 5 |
| 2. MIG-27 | 5 |
| 3. PRITHVI-II MISSILE..... | 5 |
| 4. PINAKA GUIDED WEAPONS | 5 |
| 5. BRAHMOS MISSILE | 5 |
| 6. AIR INDEPENDENT PROPULSION (AIP) SYSTEM | 6 |
| 7. MAN PORTABLE ANTI-TANK GUIDED MISSILE | 6 |
| 8. NAG- ANTI-TANK GUIDED MISSILE (ATGM)..... | 6 |
| 9. RUSTOM 2 DRONE | 7 |
| 10. ASTRA MISSILE | 7 |
| 11. SPIKE MISSILE..... | 7 |
| 12. VARAHA | 7 |
| 13. SUBMARINE KHANDERI | 7 |
| 14. INDIA'S ANTI-SATELLITE (ASAT) MISSILE..... | 8 |
| 15. BHABHA KAVACH | 8 |
| 16. AKASH MISSILE | 9 |
| 17. AGNI II MISSILE..... | 9 |
| Space Technology | 10 |
| 1. GAGANYAAN MISSION | 10 |
| 2. VYOM MITRA | 10 |
| 3. NAVIC (NAVIGATION IN INDIAN CONSTELLATION)..... | 10 |
| 4. CHANDRAYAAN-2 MISSION | 12 |
| 5. CHANDRAYAAN- 1..... | 13 |
| 6. CHANDRAYAAN-3..... | 14 |
| 7. INDIAN DATA RELAY SATELLITE SYSTEM | 14 |
| 8. GSAT-30..... | 14 |
| 9. RISAT-2BR1 | 15 |
| 10. PSLV- C47 | 16 |
| 11. GEOTAIL..... | 16 |
| 12. EAST ASIAN OBSERVATORIES CONSORTIUM | 16 |
| 13. NASA'S VOYAGER 2 SPACECRAFT | 17 |
| 14. SOLAR ORBITER MISSION..... | 17 |
| 15. VERY LARGE TELESCOPE (VLT) | 19 |
| 16. GISAT-1 — GEO IMAGING SATELLITE | 19 |
| 17. ADITYA- L1 MISSION | 20 |
| 18. PARKER SOLAR PROBE | 21 |
| 19. PUNCH (POLARIMETER TO UNIFY THE CORONA AND HELIOSPHERE) MISSION | 22 |
| 20. LAUNCH ABORT SYSTEM (LAS)..... | 22 |
| 21. ARTEMIS PROGRAMME | 22 |
| 22. LUNAR RECONNAISSANCE ORBITER (LRO)..... | 23 |
| 23. NASA TO LAUNCH DRAGONFLY..... | 23 |
| 24. OSIRIS-REX | 24 |
| 25. THIRTY METER TELESCOPE (TMT) | 25 |
| 26. SPITZER SPACE TELESCOPE | 25 |

| | | |
|-----|--|----|
| 27. | HABITABLE ZONE..... | 26 |
| 28. | ACCRETION BURST EVENT | 26 |
| 29. | SNOWEX | 27 |
| 30. | HERA MISSION | 27 |
| 31. | STARLINK NETWORK PROJECT | 28 |
| 32. | NASA RENAMES ULTIMA THULE TO 'ARROKOTH' | 29 |
| 33. | ASTEROID IMPACT DEFLECTION ASSESSMENT (AIDA) | 29 |
| 34. | NASA'S KEPLER SPACE TELESCOPE | 30 |
| 35. | COPERNICUS PROGRAMME..... | 30 |
| 36. | SATURN IS THE PLANET WITH THE HIGHEST NUMBER OF MOONS..... | 31 |
| 37. | METEOR SHOWERS | 31 |
| 38. | METHANE-POWERED ROCKET ENGINE | 31 |
| 39. | PROJECT NETRA..... | 31 |
| 40. | SAGITTARIUS A* | 32 |
| 41. | INTERPLANETARY POLLUTION | 32 |
| 42. | MAGNETOSPHERIC MULTISCALE MISSION (MMS) | 32 |
| 43. | FEDOR..... | 33 |
| 44. | GRAVITATIONAL LENSING..... | 33 |
| 45. | MARS SOLAR CONJUNCTION | 34 |
| 46. | HAYABUSA2..... | 34 |
| 47. | SPEKTR- RG | 35 |
| 48. | NASA'S INSIGHT SPACECRAFT | 35 |
| 49. | NASA'S CURIOSITY ROVER | 35 |
| 50. | CHANG'E-4..... | 36 |

Technologies / New Discoveries..... 37

| | | |
|-----|--|----|
| 1. | REVERSE OSMOSIS (RO) | 37 |
| 2. | QUANTUM TECHNOLOGIES..... | 38 |
| 3. | QUANTUM SUPREMACY..... | 38 |
| 4. | MUKTOSHRI- ARSENIC-RESISTANT RICE..... | 39 |
| 5. | WORLD'S MOST EFFICIENT LITHIUM SULPHUR BATTERY DEVELOPED IN AUSTRALIA.. | 39 |
| 6. | IRON ION BATTERY..... | 40 |
| 7. | LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY (LIGO) PROJECT | 40 |
| 8. | HYPERLOOP | 41 |
| 9. | POLYCRACK TECHNOLOGY | 41 |
| 10. | BLACK BOX IN AN AIRPLANE | 42 |
| 11. | 'VIRTUAL HUMAN' NEONS..... | 42 |
| 12. | BLOCK CHAIN TECHNOLOGY | 42 |
| 13. | EXTRAOCULAR VISION | 44 |
| 14. | HEAD ON GENERATION (HOG) TECHNOLOGY | 44 |
| 15. | NEUTRINO PROJECT | 45 |
| 16. | FUEL CELL ELECTRIC VEHICLES (FCEV) | 46 |
| 17. | BIOSIMILAR MEDICINE..... | 47 |
| 18. | FROGPHONE | 48 |
| 19. | WI-FI CALLING | 48 |
| 20. | MICRODOTS | 48 |
| 21. | FASTAG | 49 |
| 22. | SECRETAGOGIN | 49 |
| 23. | MICROBIAL FUEL CELLS | 49 |

| | | |
|-----|--|----|
| 24. | PROJECT SOLI | 50 |
| 25. | NANOPHARMACEUTICALS | 50 |
| 26. | EDGE COMPUTING | 51 |
| 27. | GAGAN ENABLED MARINER'S INSTRUMENT FOR NAVIGATION AND INFORMATION (GEMINI) DEVICE..... | 52 |
| 28. | ELASTOCALORIC EFFECT | 52 |
| 29. | HIGH-TEMPERATURE PROTON EXCHANGE MEMBRANE (HTPEM) TECHNOLOGY | 52 |
| 30. | C-DOT'S LATEST INNOVATIONS..... | 53 |

Government Initiatives / Departments 54

| | | |
|-----|--|----|
| 1. | EASE 3.0 FOR TECH-ENABLED BANKING | 54 |
| 2. | SOPHISTICATED ANALYTICAL & TECHNICAL HELP INSTITUTES (SATHI) | 54 |
| 3. | NATIONAL TECHNICAL TEXTILES MISSION | 55 |
| 4. | CSIR-IICT NUCLEAR MAGNETIC RESONANCE TEST FACILITY | 56 |
| 5. | GOVERNMENT INSTANT MESSAGING SYSTEM (GIMS) | 56 |
| 6. | ECHO NETWORK | 56 |
| 7. | RAILWIRE WI-FI..... | 57 |
| 8. | TRAKEA..... | 57 |
| 9. | PATENT PROSECUTION HIGHWAY (PPH) PROGRAMME | 57 |
| 10. | INDIA'S FIRST E-WASTE CLINIC..... | 57 |
| 11. | LOTUS-HR PROJECT | 58 |
| 12. | DEEP OCEAN MISSION | 58 |
| 13. | SAGAR MAITRI MISSION-2 | 59 |
| 14. | MANAV : HUMAN ATLAS INITIATIVE | 59 |

Biotechnology 61

| | | |
|----|---|----|
| 1. | INDIGEN GENOME PROJECT | 61 |
| 2. | GENOME INDIA PROJECT | 61 |
| 3. | NATIONAL GENOMIC GRID (NGG)..... | 62 |
| 4. | ANTIBIOTIC RESISTANCE | 62 |
| 5. | GLOBAL ANTIMICROBIAL RESISTANCE RESEARCH AND DEVELOPMENT HUB..... | 64 |
| 6. | ORGANOIDS..... | 64 |
| 7. | CRISPR TECHNOLOGY | 65 |

Events / Celebrations 66

| | | |
|----|---|----|
| 1. | NATIONAL SCIENCE DAY..... | 66 |
| 2. | INDIAN SCIENCE CONGRESS..... | 66 |
| 3. | NATIONAL MATHEMATICS DAY 2019 | 67 |
| 4. | RAMANUJAN MACHINE..... | 67 |
| 5. | NATIONAL CHILDREN'S SCIENCE CONGRESS (NCSC) | 68 |

Miscellaneous 69

| | | |
|----|--|----|
| 1. | PURIFIED TEREPHTHALIC ACID (PTA) | 69 |
| 2. | YELLOW RUST | 69 |
| 3. | LOCUST ATTACKS | 69 |
| 4. | ZERO BUDGET NATURAL FARMING (ZBNF) | 70 |
| 5. | VIKRAM SARABHAI | 71 |
| 6. | PARIS CONVENTION FOR THE PROTECTION OF INDUSTRIAL PROPERTY | 71 |

| | | |
|-----|--|----|
| 7. | RARE EARTH ELEMENTS | 72 |
| 8. | PROTECTION OF PLANT VARIETIES AND FARMERS' RIGHTS AUTHORITY (PPV&FR) | 72 |
| 9. | STRANDHOGG..... | 73 |
| 10. | MALWARE..... | 74 |
| 11. | CONTRACT FOR THE WEB..... | 74 |
| 12. | NASA UNVEILS FIRST ELECTRIC PLANE X-57 "MAXWELL" | 74 |
| 13. | ASBESTOS IN BABY POWDER | 74 |
| 14. | DEEP CARBON OBSERVATORY (CDO) | 75 |
| 15. | RICE FORTIFICATION | 76 |
| 16. | SERICIN | 77 |
| 17. | SUPERCONDUCTIVITY | 77 |

NOTES



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Defence Technology

1. Quick Reaction Surface-to-Air missiles (QRSAM)

DRDO has successfully test-fired indigenously developed **Quick Reaction Surface-to-Air missiles (QRSAM)** from a test range off the Odisha coast.

About QRSAM:

1. It has been **developed to replace the 'Akash' missile defence system, and has 360-degree coverage.**
2. It uses solid fuel propellant and has **a strike range of 25-30 km with capability of hitting multiple targets.**
3. It is **capable of hitting the low flying objects.**

2. MiG-27

On December 27, 2019 the Indian Air Force retired its fleet of **MiG-27s**.

Key facts:

- **Commissioned** into the Indian Air Force in 1985.
- It was due to the jet's heroics during the Kargil war that the aircraft earned the nickname "**bahadur**" from Air Force pilots.
- It is a single-engine, single-seater tactical strike fighter aircraft.
- Initially developed in the erstwhile Soviet Union and later indigenously manufactured by **the Hindustan Aeronautics Limited in India.**
- The MiG-27 is primarily **a 'ground attack' aircraft**, whose main role is to conduct precision air strikes in battle while tackling the adversary's air defences.

3. Prithvi-II missile

- It is **a surface-to-surface** tactical missile with **a strike range of 350 km.**
- It is **developed by DRDO under Integrated Guided Missile Development Program (IGMDP).**
- It is **capable of carrying 500 to 1,000 kg of warheads, both conventional as well as nuclear.**
- The state-of-the-art missile is powered by **liquid propulsion twin engines.**
- It uses an **advanced inertial guidance system with maneuvering orbit** to hit its target.
- It was inducted into armour of the defence forces in 2003.

4. Pinaka Guided Weapons

The indigenously developed Pinaka Guided Weapons System was successfully tested.

- Pinaka rocket systems are **developed by Defence Research and Development Organisation (DRDO).**
- The rocket system was **named after Pinaka, the bow of Lord Shiva.**
- It was initially a 30 to 40 km range rocket. **Its range was increased 70 to 80 km with Pinaka Mark II.**

5. BrahMos Missile

- It flies almost three times the speed of sound at Mach 2.8.
- The missile has been **jointly developed with Russia** and is named after the rivers Brahmaputra and Moskva in Russia.
- It is a **medium-range ramjet supersonic cruise missile** and has **a range of 290 km.**
- It is extremely difficult to be intercepted by surface to air missiles deployed on leading warships around the world.
- The BrahMos is the **fastest cruise missile** of its class in the world.

- The **range of the BrahMos missile can be extended up to 400 km** as certain technical restrictions were lifted after India became a full member of the **Missile Technology Control Regime or MTCR in 2016**.
- It is a **multiplatform** i.e it can be launched from land, air, and sea and **multi capability missile** with pinpoint accuracy that works in both day and night irrespective of the weather conditions.
- The missile is **operational with the Indian Army, Navy and Air Force**.

6. Air Independent Propulsion (AIP) System

The indigenous Air Independent Propulsion (AIP) system to enhance the endurance of conventional submarines being developed by the Defence Research and Development Organisation (DRDO) reached a milestone with the successful operation of a land-based prototype. All Scorpene submarines of the Navy are planned to be equipped with an AIP module in due course.

What is Air-independent propulsion?

It is **any technology which allows a non-nuclear submarine to operate without the need to access atmospheric oxygen (by surfacing or using a snorkel)**.

It can **augment or replace the diesel-electric propulsion system of non-nuclear vessels**.

It is **based on the combustion of stored oxygen and ethanol to augment battery-powered propulsion**.

Significance of AIP:

- AIP significantly improves stealth because it **enables a submarine to generate electricity for services and battery charging and propulsion while completely submerged**.
- AIP systems also **generate electricity**, powering a submarine to operate and also generate oxygen, lighting and amenities for crew.
- The Non-nuclear submarines running on battery power or AIP **can be virtually silent**.

7. Man Portable Anti-Tank Guided Missile

- Man Portable Anti-Tank Guided Missile is an **Indian third-generation fire-and-forget anti-tank guided missile**.
- Developed by DRDO.
- Incorporated with state-of-the-art Infrared Imaging Seeker along with advanced avionics.

List of India's Anti Tank guided missile:

- DRDO Anti-Tank Missile.
- Amogha missile.
- Nag missile.
- Man-Portable Anti-tank Guided Missile (MPATGM).

8. NAG- ANTI-TANK GUIDED MISSILE (ATGM)

- Indian Army has successfully conducted summer user trials of **NAG, 3rd Generation Anti-Tank Guided Missile (ATGM)**.
- The NAG missile is a third-generation anti-tank guided missile, which has top attack capabilities that can effectively engage and destroy all known enemy tanks during day and night.
- It uses an imaging infrared seeker in lock-on-before-launch mode.
- It is launched from **NAG missile carrier (NAMICA)** which is capable of carrying up to 6 combat missiles.
- **Range:** Minimum-500 metres and Maximum- 4 kilometres.
- **Developed** by DRDO.

9. Rustom 2 drone

- Rustom 2 **drone** is a medium-altitude, long- endurance **unmanned aerial vehicle** developed by DRDO.
- The objective of this drone is to carry out **surveillance** for the armed forces with an endurance of 24 hours.
- The drone was developed for use by all three services of the Indian armed forces, primarily for intelligence, surveillance and reconnaissance (ISR) operations.
- The medium-altitude prototype can fly at over 22,000 ft and is a long-endurance (MALE) UAV that has an approximate flight time of 20 hours.
- It can fly at around 280 km/h and carry a variety of payloads like Medium Range Electro Optic (MREO), Long Range Electro Optic (LREO), Synthetic Aperture Radar (SAR), Electronic Intelligence (ELINT).

10.Astra Missile

- It is the indigenously developed **Beyond Visual Range (BVR) air-to-air missile**.
- It is the first air-to-air missile developed by India.
- It is an **all-weather, state-of-the-art missile developed by DRDO** and can engage and destroy enemy aircraft at supersonic speed (1.2 Mach to 1.4 Mach) in head-on (up to 80 km) and tail-chase (up to 20 km) modes.
- The 3.8 metre tall Astra is a radar homing missile and the smallest of the DRDO-developed missiles and can be launched from different altitudes.
- It can reach up to 110 km when fired from an altitude of 15 km, 44 km when launched from an altitude of eight km and 21 km when fired from sea level.
- It features **mid-course inertial guidance with terminal active radar homing**.
- Astra has been **integrated with Indian Air Force's Sukhoi Su-30MKI** and will be integrated with Dassault Mirage 2000, HAL Tejas and Mikoyan MiG-29 in the future.

11.Spike Missile

- Indian Army places order for Israeli anti- tank Spike missiles.
- Israeli anti-tank Spike missiles from Israel are **multi- platform, cutting-edge precise, multi-mission, and multi-range electro-optical missiles**. These missiles have **capabilities of fire, observe, update, fire-and- forget as well as allowing attack of hidden targets**.
- Israeli anti-tank Spike missiles are **manufactured by Rafael Advanced Defense Systems Ltd**.
- These missiles have the **capability of targeting anything at a range of four kilometers**. These **can be deployed in both plains and mountains**.

12.Varaha

- It is an **Indian Coast Guard Ship** commissioned recently.
- It will **enhance the surveillance and patrolling capabilities of Indian Coast Guard and reinforce their role as 'Sentinels of our Seas'**.
- It is the **fourth in series of seven 98-m Offshore Patrol Vessels (OPV)** of Indian Coast Guard (ICG).
- It has been designed and built indigenously by **Larsen & Toubro (L&T)** at its Katupalli ship building yard in North Chennai.

13.SUBMARINE KHANDERI

- Mazagon Dock Shipbuilders Limited delivers second Scorpene submarine "**KHANDERI**" to Indian Navy.
- **Mazagon Dock Limited (MDL)**, Mumbai, is manufacturing six Scorpene submarines under technology transfer from Naval Group of France under a 2005 contract worth \$3.75 bn.

- The submarine 'KHANDERI' is **named after the wide snouted Saw fish**, a deadly sea predator of the great Indian Ocean.
- The first Submarine Khanderi was **commissioned into the Indian Navy on 06th December 1968** and decommissioned on 18th October 1989 after more than 20 years of yeoman service to the nation.
- **Names of upcoming submarines:** Karanj, Vela, Vagir and Vagsheer.

14. INDIA'S ANTI-SATELLITE (ASAT) MISSILE

- **Mission Shakti** is a joint programme of the Defence Research and Development Organisation (DRDO) and the Indian Space Research Organisation (ISRO).
- As part of the mission, an **anti-satellite (A-SAT) weapon** was launched and targeted an Indian satellite which had been decommissioned.
- The target of the test was a satellite present in a **low Earth orbit**.
- The test sparked concerns regarding the creation of space debris.

Significance:

- India is only the **4th country to acquire such a specialised and modern capability**, and Entire effort is indigenous. Till now, only the US, Russia and China had the capability to hit a live target in space.
- India's successful demonstration of the ASAT capability is said to signify its **ability to intercept an intercontinental ballistic missile**.

What is space debris?

- Space junk is an ever-growing problem with more than 7,500 tonnes of redundant hardware now thought to be circling the Earth. Ranging from old rocket bodies and defunct spacecraft through to screws and even flecks of paint – this material poses a collision hazard to operational missions.
- The rising population of space debris increases the potential danger to all space vehicles, but especially to the International Space Station (ISS), space shuttles, satellites and other spacecraft.

Technologies that can tackle the problem in future are:

- **Nasa's Space Debris Sensor** orbits the Earth on the International Space Station. The sensor was attached to the outside of the space station's European Columbus module in December 2017. It will detect millimetre- sized pieces of debris for at least two years, providing information on whatever hits it such as size, density, velocity, orbit and will determine whether the impacting object is from space or a man-made piece of space debris.
- **REMOVEdebris**, satellite contain two cubesats that will release simulated space debris so that it can then demonstrate several ways of retrieving them.
- **Deorbit mission:** e.Deorbit is a planned European Space Agency active space debris removal mission developed as a part of their Clean Space initiative.
- Other technologies include moving objects with a powerful **laser beam**. It is important to start doing that soon, current scientific estimates predict that without active debris removal, certain orbits will become unusable over the coming decades.

15. Bhabha Kavach

- **India's first Lightest and indigenous Bullet Proof Jacket 'Bhabha Kavach'** from Ordnance Factory Board gets nod of MHA.
- Developed by OFB and MIDHANI this state-of-the-art jacket can withstand 7.62mm hard steel core or bullets fired from an AK-47 rifle, 5.56mm INSAS bullet and even the recently decommissioned 7.65mm bullet of self-loading rifle (SLR).

- It is half KG lesser than the prescribed weight of MHA along with the 360 Degree Protection and has achieved the protection level of NIJ III+.
- Bhabha Kavach only weighs 9.2kg and is a major breakthrough for the Indian armed forces.

16.AKASH MISSILE

- Defence Research and Development Organisation (DRDO) has successfully test fired AKASH-MK-1S missile.

Key facts:

- This is **surface to air anti-aircraft missile** with a strike range of 25 km and capability to carry warhead of 60 kilogram.
- It can reach an altitude of 18 km and can be fired from both tracked and wheeled platforms.
- The missile is guided by a phased array fire control radar called 'Rajendra' which is termed as Battery Level Radar (BLR) with a tracking range of about 60 km.
- The Akash-MK-1S is capable of striking down enemy fighter jets and drones very effectively and accurately.
- The Akash surface-to-air missile was designed to intercept enemy aircraft and missiles from a distance of 18 to 30 km.

17.Agni II missile

- India recently conducted successfully the first night trial of Agni-II, its versatile **surface-to-surface medium range nuclear-capable missile**.
- The missile has a **strike range of 2000 km**.
- Agni-II, an **intermediate range ballistic missile (IRBM)**, has already been inducted into the armed forces.
- The **two-stage missile** equipped with **advanced high accuracy navigation system**, was guided by a novel state-of-the-art command and control system and propelled by **solid rocket propellant system**.
- Agni-II was developed by **Advanced Systems Laboratory** along with other DRDO laboratories and integrated by the Bharat Dynamics Limited, Hyderabad.
- Agni-II is part of the **Agni series of missiles** which includes 700-km range Agni-I, 3,000-km range Agni-III, Agni-IV and Agni-V.

Space Technology

1. Gaganyaan mission

- **Gaganyaan** is an **Indian crewed orbital spacecraft** intended to be the formative spacecraft of the **Indian Human Spaceflight Programme**. The spacecraft is being designed to carry three astronauts to space.
- The crewed vehicle is planned to be launched on ISRO's **GSLV Mk III**.
- ISRO aims to launch **Gaganyaan** before the 75th anniversary of India's independence in 2022.
- **Defence Research and Development Organisation (DRDO)** will provide support for critical human-centric systems and technologies like space grade food, crew healthcare, radiation measurement and protection, parachutes for the safe recovery of the crew module and fire suppression system.
- ISRO's Human Space Flight Centre and **Glavcosmos**, which is a subsidiary of the Russian state corporation Roscosmos, signed an agreement on July 1, 2019 for **cooperation in the selection, support, medical examination and space training of Indian astronauts**.
- Isro will receive assistance from the **French space agency CNES**, in terms of expertise various fields including space medicine, astronaut health monitoring, radiation protection and life support.
- On January 22, 2020 ISRO announced **Vyommitra**, a Female Robot who will accompany other astronauts in the mission.

A new center namely **Human Space Flight Centre (HSFC)** is created within ISRO/DOS with the responsibility to act as the lead center for Human Space Flight Program, Gaganyaan.

A **Gaganyaan National Advisory Council** has been created with members from different institutions and industries

The Gaganyaan Advisory Council comprises of Secretaries of Department of Space, Department of Science and Technology, Department of Defence Research and Development, Department of Scientific and Industrial Research, Principal Scientific Advisor to PM, Senior Officials from Armed Forces, Indian Coast Guard, Former Chairman of ISRO, Member of Space Commission, Former Director of Aeronautical Development Agency, Former Indian Astronaut, Directors of Premier Academic and Research Institutions and Heads of various Indian Industries.

It discusses overall **project status of Gaganyaan**, covering technical details as well as collaboration with various national stake holders.

2. Vyom Mitra

It is ISRO's **first woman astronaut**.

- It is a **female spacefaring humanoid robot** developed by the Indian Space Research Organisation to function on-board the *Gaganyaan*, a crewed orbital spacecraft.
- Vyommitra, equipped with a head, two arms and a torso, is built to **mimic crew activity inside the crew module of Gaganyaan**.
- **Functions:** Attaining launch and orbital postures, responding to the environment, generating warnings, replacing carbon dioxide canisters, operating switches, monitoring of the crew module, receiving voice commands, responding via speech (bilingual).



3. NavIC (Navigation in Indian Constellation)

Qualcomm Technologies has unveiled mobile chipsets supporting **the Indian regional satellite navigation system - NavIC (Navigation in Indian Constellation)**.

The release of chipsets will help accelerate the adoption of NavIC by smartphone Original Equipment Manufacturers (OEMs).

Global Standards body **3rd Generation Partnership Project (3GPP)**, which develops protocols for mobile telephony, has approved India's regional navigation system NAVIC. The specification approval will **boost commercial use** of NaVIC by international and domestic mobile device makers.

Acceptance of NaVIC by 3GPP would also bring NaVIC technology to the **commercial market for its use in 4G, 5G and Internet of Things (IOT)**.

3GPP comprises seven telecommunications standard development organisations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC) from across the world and provides their members with a stable environment to produce specifications that define 3GPP technologies. 3GPP currently has global navigation satellite system support from BDS (Chinese), Galileo (European), GLONASS (Russian) & GPS (US) for cellular positioning systems.

US Congress has consented to designate India's **Navigation in Indian Constellation (NavIC) as its "allied" navigational satellite system along with the Galileo of the European Union and QZSS of Japan**. The designation of India's NAVIC as an "allied system" is part of the American effort to develop a **prototype program for Multi-Global Navigation Satellite System (GNSS) receiver Development**.

US also designates Russia's GLONASS and Chinese Beidou as a "non-allied system". It means that the US satellite navigation system will not co-operate or exchange data with these two satellite navigation systems.

What is NAVIC?

The **Indian Regional Navigation Satellite System (IRNSS)**, with an operational name of **Navigation with Indian Constellation (NavIC)** is **an independent regional navigation satellite system** designed to provide **position information in the Indian region and 1500 km around the Indian mainland**.

Services provided:

IRNSS would provide two types of services, namely **Standard Positioning Services available to all users and Restricted Services** (an encrypted one) **provided to authorised users** (including the military).

NavIC-based vehicle trackers system has been made compulsory to all commercial vehicles.

Its applications include:

1. Terrestrial, Aerial and Marine Navigation.
2. Disaster Management.
3. Vehicle tracking and fleet management.
4. Integration with mobile phones.
5. Precise Timing.
6. Mapping and Geodetic data capture.
7. Terrestrial navigation aid for hikers and travellers.
8. Visual and voice navigation for drivers.

How many satellites does NAVIC consist of?

It is a regional system and so its constellation will **consist of seven satellites**.

Three of these will be geostationary over the Indian Ocean, i.e., they will appear to be stationary in the sky over the region, and **four will be geosynchronous** – appearing at the same point in the sky at the same time every day. (two additional satellites on ground as stand-by.)

This configuration **ensures each satellite is being tracked by at least one of fourteen ground stations at any given point of time**, with a high chance of most of them being visible from any point in India.

Why it is necessary to have indigenous global navigation system?

Having a global navigation system bolsters the ability of a nation to serve as a net security provider, especially through the guarantee of such assurance policies. It can also play a significant

PROVIDES INDIA WITH ASSURED NAVIGATION SERVICE FOR VITAL CIVILIAN & MILITARY APPLICATIONS WITHOUT HAVING TO DEPEND ON ANOTHER COUNTRY; FIRST SATELLITE TO BE LAUNCHED ON JULY 1; REMAINING 6 BY 2015

www.indiandefensenews.in

NAVIC : INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM

7 SATELLITES

3 GEOSTATIONARY **ORBIT ALTITUDE 36,000 KM**

4 GEOSYNCHRONOUS **COST ₹1,420 CRORES**



| | | |
|---|--|--|
| Covers India and up to 1,500 km beyond its borders | 3 extremely accurate rubidium atomic clocks in each satellite | GPS receivers will not work; need special receivers (yet to be developed) |
| IRNSS provides Standard Positioning Service | Open to all users | Accuracy better than 20 metres |
| 3 satellites in geostationary orbit – appear from ground to be at fixed positions in the sky | 4 satellites in geosynchronous orbit – in pairs, move in two inclined orbits – appear from ground to travel in figure '8' – assist in accurate position determination | |

role in relief efforts post disasters such as the tsunami in the Indian Ocean region in 2004 and the Pakistan-India earthquake in 2005.

4. Chandrayaan-2 mission

- **Chandrayaan-2** is the **second lunar exploration mission** developed by the Indian Space Research Organisation (ISRO), after Chandrayaan-1.
- It currently consists of a **lunar orbiter**, and also included the **Vikram lander**, and the **Pragyan lunar rover**, all of which were developed in India. The main scientific objective is to **map and study the variations in lunar surface composition**, as well as the **location and abundance of lunar water**.
- The spacecraft was launched on its mission to the Moon from the second launch pad at the Satish Dhawan Space Centre on 22 July 2019 by a **GSLV Mark III**.
- The craft reached the Moon's orbit on 20 August 2019 and began orbital positioning manoeuvres for the landing of the **Vikram** lander.
- **Vikram** and the rover were scheduled to land on the near side of the Moon, in the south polar region on 6 September 2019.
- A successful soft landing would have made India the fourth country after USSR, US and PRC to do so.
- However, the lander deviated from its intended trajectory and had lost communication when touchdown confirmation was expected.
- ISRO may re-attempt a soft landing with **Chandrayaan-3**.

Goals and objectives of the mission:

- The **primary objective** of Chandrayaan 2 was to demonstrate the ability to soft-land on the lunar surface (lunar south pole) and operate a robotic rover on the surface.
- **Scientific goals** included studies of lunar topography, mineralogy, elemental abundance, the lunar exosphere, and signatures of hydroxyl and water ice.

Other objectives of the mission:

- To identify or to find out the minerals and indicators of hydroxyl and water molecules.
- To study the surface of the moon.

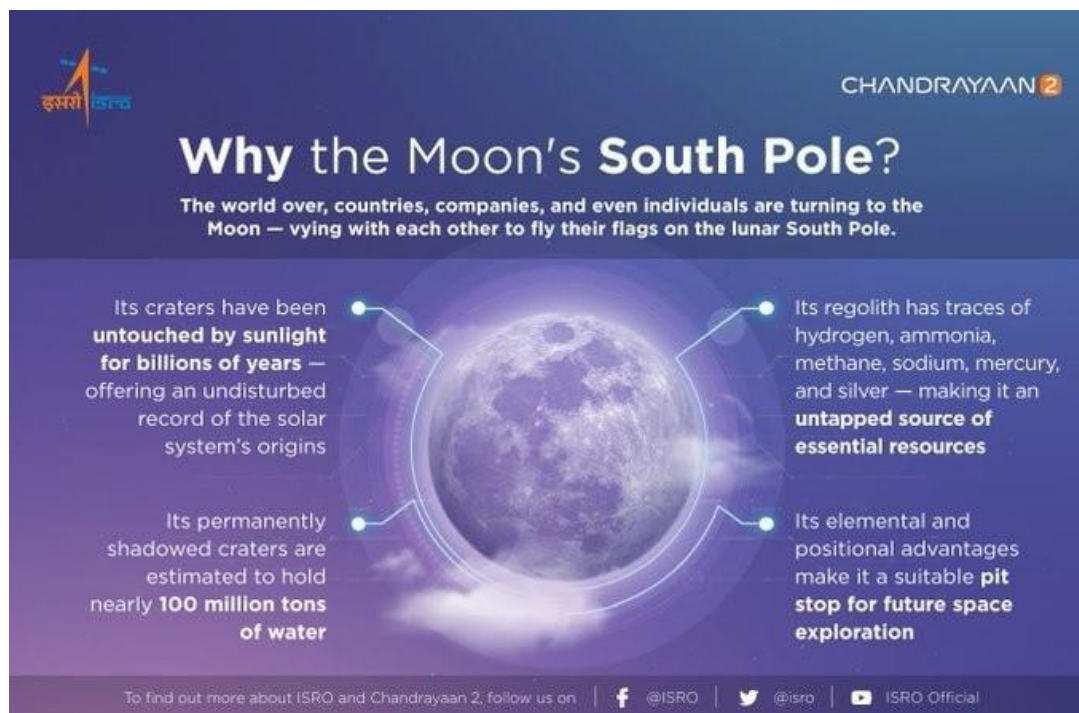
- To study the density of the electrons in the Moon's ionosphere that is the uppermost part of the atmosphere that is ionised by radiation.
- The Orbiter will observe the lunar surface and relay communication between Earth and Chandrayaan 2's Lander

Why is the study of the Moon important?

- The **Moon is the closest celestial body at which space discovery can be attempted and documented**. It is also a promising testbed to illustrate technologies required for deep-space missions. Chandrayaan-2 attempts to foster a new age of discovery, increase our understanding of space, stimulate the advancement of technology, promote global alliances, and inspire a future generation of explorers and scientists.
- Extensive mapping of lunar surface to study variations in lunar surface composition is essential to **trace back the origin and evolution of the Moon**. Evidence for water molecules discovered by Chandrayaan-1, requires further studies on the extent of water molecule distribution on the surface, below the surface and in the tenuous lunar exosphere to address the origin of water on the Moon.

WHY THE SOUTH POLE?

- The south polar region of the Moon has not received sunlight for billions of years and is among the coldest spots in the Solar System. This, Isro says, makes **lunar south pole region ripe to contain tonnes of water and "an undisturbed record" of the Solar System's origins**.



5. Chandrayaan- 1

- Chandrayan-1 was launched by India in October, 2009 using PSLV-C11.
- Scientists have found **frozen water deposits** in the darkest and coldest parts of the Moon's polar regions using data from the Chandrayaan-1 spacecraft.
- Indian Space Research Organisation (ISRO) lost communication with Chandrayaan-1 on August 29, 2009, barely a year after it was launched on October 22, 2008.
- The Chandrayaan-1 mission performed **high-resolution remote sensing of the moon** in visible, near infrared (NIR), low energy X-rays and high-energy X-ray regions.
- One of the objectives was to **prepare a three-dimensional atlas** (with high spatial and altitude resolution) of both near and far side of the moon.

- It aimed at conducting chemical and mineralogical mapping of the entire lunar surface for distribution of mineral and chemical elements such as Magnesium, Aluminium, Silicon, Calcium, Iron and Titanium as well as high atomic number elements such as Radon, Uranium and Thorium with high spatial resolution.

6. Chandrayaan-3

- **Chandrayaan-3** is a planned third lunar exploration mission by Indian Space Research Organisation.
- Chandrayaan-3 will be mission repeat of Chandrayaan-2 and will only include a lander and a rover similar to that of Chandrayaan-2 and will not have an orbiter.

7. Indian Data Relay Satellite System

India plans to ring in its own era of **space-to-space tracking and communication of its space assets** by putting up a new satellite series called **the Indian Data Relay Satellite System**.

What is IDRSS? Why it is vital?

The IDRSS is planned **to track and be constantly in touch with Indian satellites, in particular those in low-earth orbits which have limited coverage of earth**.

It will be **a set of satellites** that will track, send and receive information from other Indian Satellites.

IDRSS satellites of the 2,000 kg class would be **launched on the GSLV launcher to geostationary orbits** around 36,000 km away.

A satellite in GEO covers a third of the earth below and three of them can provide total coverage.

Significance:

In the coming years, it will be vital to Indian Space Research Organisation (ISRO), whose roadmap is dotted with advanced LEO missions such as space docking, space station, as well as distant expeditions to moon, Mars and Venus. It will also be useful in monitoring launches.

The first beneficiary would be the prospective crew members of the **Gaganyaan mission of 2022** who can be fully and continuously in touch with mission control throughout their travel.

8. GSAT-30

The first mission of **the Indian Space Research Organisation (ISRO)** in 2020, India's telecommunication satellite **GSAT-30** was successfully launched.

The launch took place from the Spaceport in **French Guiana**.

The launch vehicle is named **Ariane 5 VA-251**.

Key facts:

- GSAT-30 derives its heritage from ISRO's earlier INSAT/GSAT satellite series and will replace INSAT-4A in orbit.
- GSAT-30 is configured on ISRO's enhanced I-3K Bus structure to provide communication services from Geostationary orbit.

GSAT-30 uses two satellite frequencies:

It gives the Indian mainland and islands coverage in **the Ku band**, and extended coverage in a wider area stretching from Australia to Europe in the lower-frequency **C-band**.

The Ku and C bands are part of a spectrum of frequencies, ranging from 1 to 40 gigahertz, that are used in satellite communications.

Services:

With a mission life of over 15 years, GSAT-30 will provide DTH [direct-to-home] television Services, connectivity to VSATs [Very Small Aperture Terminals] for ATM, stock exchange, television uplinking and teleport services, Digital Satellite News Gathering (DSNG) and e-governance applications.

What is Arianespace?

It is **the world's first commercial launch service provider** and since the launch of India's APPLE experimental satellite on Ariane Flight L03 in 1981, Arianespace has orbited 24 satellites, including Gsat-30, for the Indian space agency.

9. RISAT-2BR1

India's Polar Satellite Launch Vehicle, in its **fiftieth flight (PSLV-C48)**, has successfully **launched RISAT-2BR1** along with **nine commercial satellites from the Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota.**

This is **PSLV's 50th successful mission and the 75th launch vehicle mission from SDSC SHAR, Sriharikota.**

What is RISAT-2BR1?

It is a **radar imaging earth observation satellite.**

It provides services in the field of **agriculture, forestry and disaster management.** Its **mission life is 5 years.**

What is PSLV?

Polar Satellite

Launch Vehicle is **an indigenously-developed expendable launch system of the ISRO.**

- It comes in the category of medium-lift launchers with a reach up to various orbits, including the Geo Synchronous Transfer Orbit, Lower Earth Orbit, and Polar Sun Synchronous Orbit.

Difference between PSLV and GSLV:

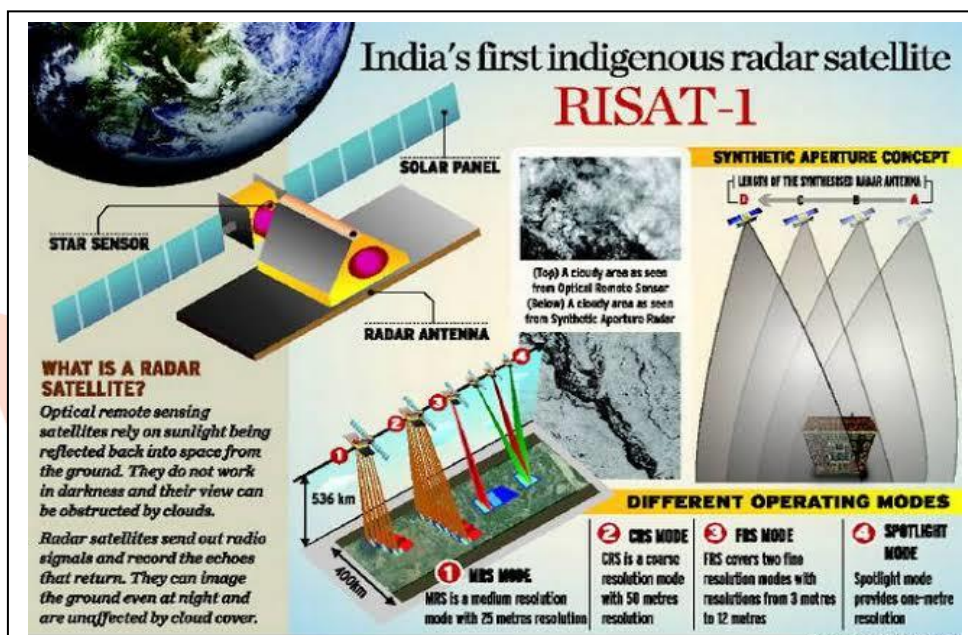
India has two operational launchers- **Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV).**

GSLV was **developed to launch the heavier INSAT class of geosynchronous satellites into orbit.**

Different orbits:

There are **three main types of Earth orbits- high Earth orbit, medium Earth orbit and low Earth orbit.** Which orbit a particular satellite is placed in depends on its function.

- When satellites are about 36,000 km from the Earth's surface, they enter what is called **the high Earth orbit.** Here, it orbits in sync with the Earth's rotation, creating the impression that the satellite is stationary over a single longitude. Such a satellite is said to be **geosynchronous.**
- Just as the geosynchronous satellites have a sweet spot over the equator that allows them to stay over one spot on Earth, polar-orbiting satellites have a sweet spot that allows them to



stay in one time. This orbit is **a Sun-synchronous orbit**, which means that whenever and wherever the satellite crosses the equator, the local solar time on the ground is always the same.

10. PSLV- C47

India's **Polar Satellite Launch Vehicle, PSLV-C47** has launched **Cartosat-3 and 13 commercial nanosatellites** into **Sun Synchronous orbit** from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota.

What is Cartosat-3?

It is a third-generation agile advanced **earth observation satellite** with high-resolution imaging capability.

Developed by **the Indian Space Research Organization (Isro)**, it will replace the IRS series.

Applications:

Cartosat-3 could be potentially used for weather mapping and cartography. It aims to address the increased demands for large scale urban planning, rural resource and infrastructure development, coastal land use and land cover.

11. Geotail

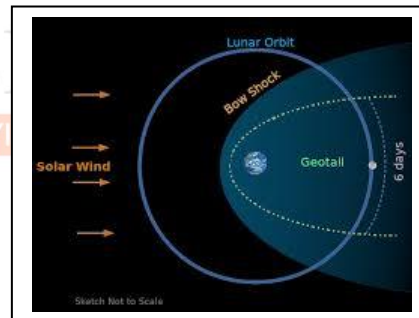
An instrument on **Chandrayaan-2, CLASS (Chandrayaan 2 Large Area Soft X-ray Spectrometer)**, designed to detect signatures of elements in the Moon's soil, had detected charged particles during the mission.

What is Geotail?

A region in space that allows the best observations. The region **exists as a result of the interactions between the Sun and Earth**.

How is it formed?

- The Sun emits the solar wind, which is a continuous stream of charged particles.
- These particles are embedded in the extended magnetic field of the Sun. Since the Earth has a magnetic field, it obstructs the solar wind plasma.
- This interaction results in the formation of a magnetic envelope around Earth.
- On the Earth side facing the Sun, the envelope is compressed into a region that is approximately three to four times the Earth radius.
- On the opposite side, the envelope is stretched into a long tail, which extends beyond the orbit of the Moon.
- It is this tail that is called the **geotail**.
- Once every 29 days, the Moon traverses the geotail for about six days.



12. East Asian Observatories Consortium

India is in preliminary discussions to be a part of **the East Asian Observatories Consortium** of eight countries committed to build large telescopes and pool resources.

About EAO (East Asian Observatory):

Formed by **EACOA (East Asian Core Observatories Association)** for the purpose of pursuing joint projects in astronomy within the East Asian region.

- The intention of EAO is **to build and operate facilities, which will enhance and leverage existing and planned regional facilities**.

- It will also **raise funding and to build an observatory staff, separate from that of the EAOA institutions.**
- The EAO is chartered as **a non-profit Hawaii corporation.**
- Its first task is to assume the operation of **the James Clerk Maxwell Submillimetre Telescope (JCMT)** on the summit of Maunakea, Hawai'i.
- It consists of China, Japan, Taiwan, Korea as **full members** and Thailand, Vietnam, Malaysia and Indonesia as **'observers'.**

Implications for India:

- Having India join the group could mean **the establishment of new kinds of telescopes — one proposed being in Tibet** — that could aid the observation of new black holes and throw light on cosmic phenomena.

13. NASA's Voyager 2 spacecraft

NASA has managed to fix its **Voyager-2** probe remotely, almost 11.5 billion miles away from its location.

Accomplishments so far:

Voyager 2 is the only probe ever to study Neptune and Uranus during planetary flybys.

It is **the second man-made object to leave the heliosphere.**

Voyager 2 is **the only spacecraft to have visited all four gas giant planets — Jupiter, Saturn, Uranus and Neptune — and discovered 16 moons, as well as phenomena like Neptune's mysteriously transient Great Dark Spot, the cracks in Europa's ice shell, and ring features at every planet.**

What is Interstellar space?

Scientists use the heliopause to mark where interstellar space begins, although depending on how you define our solar system it can stretch all the way to the Oort Cloud, which begins 1,000 times farther away from the sun than Earth's orbit.

The Heliosphere:

The heliosphere is **a bubble around the sun created by the outward flow of the solar wind from the sun and the opposing inward flow of the interstellar wind.** That heliosphere is the region influenced by the dynamic properties of the sun that are carried in the solar wind—such as magnetic fields, energetic particles and solar wind plasma. The heliopause marks the end of the heliosphere and the beginning of interstellar space.

About Voyager mission:

- Launched in the 1970's, and the probes sent by NASA were only meant to explore the outer planets – but they just kept on going.
- Voyager 1 departed Earth on 5 September 1977, a few days after Voyager 2 and left our solar system in 2013.
- **The mission objective of the Voyager Interstellar Mission (VIM)** is to extend the NASA exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond.
- **The Voyager spacecraft are the third and fourth human spacecraft to fly beyond all the planets in our solar system.**

14. Solar Orbiter mission

Solar Orbiter mission was launched recently.

- The mission is **a collaboration between ESA (the European Space Agency) and NASA.**
- The spacecraft was launched from **Cape Canaveral on a United Launch Alliance Atlas V rocket.**

About Solar Orbiter:

Solar Orbiter is **a mission dedicated to solar and heliospheric physics.**

It was selected as **the first medium-class mission of ESA's Cosmic Vision 2015-2025 Programme.** This is **the first mission that will provide images of the sun's north and south poles** using a suite of six instruments on board that will capture the spacecraft's view.

It is **a seven-year mission** and will come within 26 million miles of the sun. It will be able to brave the heat of the sun because it has **a custom titanium heat shield coated in calcium phosphate** so that it can endure temperatures up to 970 degrees Fahrenheit.

Objectives:

- Solar Orbiter will be used to examine **how the Sun creates and controls the heliosphere**, the vast bubble of charged particles blown by the solar wind into the interstellar medium.
- The spacecraft will combine in situ and remote sensing observations to **gain new information about the solar wind**, the heliospheric magnetic field, solar energetic particles, transient interplanetary disturbances and the Sun's magnetic field.

Solar Orbiter will set about answering four top-level science questions:

- What drives the solar wind and where does the coronal magnetic field originate from?
- How do solar transients drive heliospheric variability?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
- How does the solar dynamo work and drive connections between the Sun and the heliosphere?

Significance:

Understanding the **sun's magnetic field and solar wind** are key because they **contribute to space weather**, which impacts Earth by interfering with networked systems like GPS, communications and even astronauts on the International Space Station. The sun's magnetic field is so massive that it stretches beyond Pluto, providing a pathway for solar wind to travel directly across the solar system.

Journey ahead:

It will take Solar Orbiter about two years to reach its highly elliptical orbit around the sun. Gravity assists from Earth and Venus will help swing the spacecraft out of the ecliptic plane, or the space that aligns with the sun's equator, so it can study the sun's poles from above and below. The mission will work in tandem with **NASA's Parker Solar Probe**, which is currently orbiting the sun on a seven-year mission and just completed its fourth close approach of the star.

Background:

Solar Orbiter follows *the Ulysses spacecraft*, another collaboration between ESA and NASA that launched in 1990 and also flew over the sun's poles. Ulysses completed three passes of the sun before its mission ended in 2009, but its view was limited to what it could see from the sun's equator.

15. Very Large Telescope (VLT)

Using *the European Space Organisation's (ESO) Very Large Telescope (VLT)*, astronomers have noticed the unprecedented dimming of *Betelgeuse, a red supergiant star* (over 20 times bigger than the Sun) in the constellation *Orion*.

Along with the dimming, the star's shape has been changing as well, as per recent photographs of the star taken using the VISIR instrument on the VLT.

About VLT:

It is *the world's most advanced optical instrument*, consisting of four Unit Telescopes with main mirrors of 8.2m diameter and four movable 1.8m diameter Auxiliary Telescopes.



- The telescopes can work together, to form a giant '*interferometer*', *the ESO Very Large Telescope Interferometer*, allowing astronomers to see details up to 25 times finer than with the individual telescopes.
- **Location:** Atacama Desert, Northern Chile.
- The VLT *consists of four individual telescopes*. They are generally used separately but can be used together to achieve very high angular resolution.
- The four separate optical telescopes are known as *Antu, Kueyen, Melipal, and Yepun*, which are all words for astronomical objects in *the Mapuche language*.
- The VLT operates at **visible and infrared wavelengths**.

16. GISAT-1 — Geo Imaging Satellite

- The Indian Space Research Organisation (ISRO) announced that its launch of a new type of **earth observation satellite, GISAT-1**, has been postponed due to "technical reasons".
- GISAT-1 is short for **Geo-Imaging Satellite** and is the first of two **earth imagers** planned in a geostationary orbit.
- It will constantly look over the Indian subcontinent from a perch 36,000 km above, adding a new edge to **national security**, apart from routine uses of earth imaging.
- The 2,268-kg spacecraft will provide **imageries of "large areas of interest"** on earth in almost real time and at frequent intervals,
- Until now, all Indian EOs have been in the range of 600-800 kg, placed at around 600 km from earth and circle it pole to pole once in around 90 minutes. They were launched by the smaller PSLV rocket.
- GISAT-1, as also its future pair GISAT-2, will seem to be fixed over the same region, India, from a 36,000-km distance and go around earth equatorially with the same 24-hour orbital period as earth. The medium-lift GSLV is their launcher.
- Its multi-spectral and hyperspectral payloads would help to get "spectral signatures for **agriculture, forestry, mineralogy, disaster warning, cloud properties, snow and glaciers and oceanography.**"

Background:

- Earth Observation Satellites of ISRO has been successfully able to establish **many operational applications in the country**. Both at Central and State level, there are large number of users who utilise space-based inputs for various purposes.

- Some of the important missions of ISRO, in terms of IRS series of satellites, that has enabled unique applications of space-based imaging are, Cartosat-1 & 2, Resourcesat-1 & 2, Oceansat-1 & 2, Risat-1, Megha-Tropiques, SARAL, Scatsat, INSAT series, and host of other satellites.

17. Aditya- L1 mission

Indian Space Research Organisation (ISRO) is preparing to send its first scientific **expedition to study the Sun**. Named **Aditya-L1**, will observe the Sun from a close distance, and try to obtain information about its **atmosphere and magnetic field**.

About Aditya- L1 mission:

What is it? It is **India's first solar mission**.

It will be launched using **the Polar Satellite Launch Vehicle (PSLV) in XL configuration**.

The space-based observatory will have **seven payloads (instruments)** on board to study the Sun's corona, solar emissions, solar winds and flares, and Coronal Mass Ejections (CMEs), and will carry out round-the-clock imaging of the Sun.

Objectives:

- Study the sun's outer most layers, the corona and the chromospheres.
- Collect data about coronal mass ejection, which will also yield information for space weather prediction.

Significance of the mission:

The data from Aditya mission will be immensely helpful in discriminating between different **models for the origin of solar storms and also for constraining how the storms evolve** and what path they take through the interplanetary space from the Sun to the Earth.

Position of the satellite:

In order to get the best science from the sun, continuous viewing of the sun is preferred without any occultation/ eclipses and hence, Aditya- L1 satellite will be placed in **the halo orbit around the Lagrangian point 1 (L1) of the sun-earth system**.

What are Lagrangian points and halo orbit?

Lagrangian points are the locations in space where the combined gravitational pull of two large masses roughly balance each other. Any small mass placed at that location will remain at constant distances relative to the large masses.

There are five such points in Sun-Earth system and they are denoted as L1, L2, L3, L4 and L5.

A halo orbit is a periodic three-dimensional orbit near the L1, L2 or L3.

Why do we study the sun and the solar wind?

The sun is **the only star we can study up close**. By studying this star we live with, we learn more about stars throughout the universe.

The sun is **a source of light and heat for life on Earth**. The more we know about it, the more we can understand how life on Earth developed.

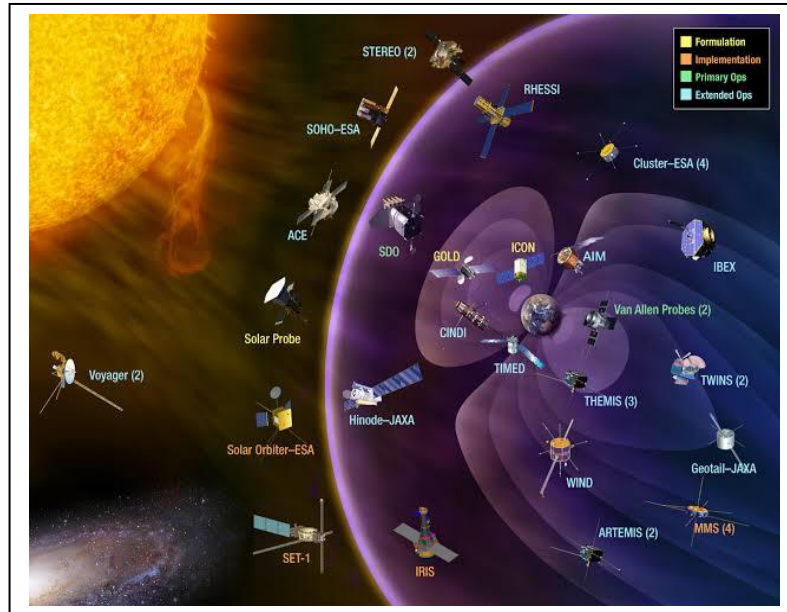
It is **the source of the solar wind**; a flow of ionized gases from the sun that streams past Earth at speeds of more than 500 km per second (a million miles per hour).

Disturbances in the solar wind shake Earth's magnetic field and pump energy into the radiation belts, part of a set of changes in near-Earth space known as space weather.

Effects On satellites: Space weather can change the orbits of satellites, shorten their lifetimes, or interfere with onboard electronics. The more we learn about what causes space weather – and how to predict it – the more we can protect the satellites we depend on.

Safety and preparedness:

The solar wind dominates the space environment. As we send spacecraft and astronauts further and further from home, we must understand this space environment just as early seafarers needed to understand the ocean.



18. Parker Solar Probe

- On August 12, 2019 NASA's **Parker Solar Probe** completed a year in service. It is part of NASA's "Living With a Star" programme that explores different aspects of the Sun-Earth system.
- The probe seeks to gather information about the Sun's atmosphere and NASA says that it "will revolutionise our understanding of the Sun". **It is also the closest a human-made object has ever gone to the Sun.**

About the mission:

- **What is it?** NASA's historic Parker Solar Probe mission will revolutionize our understanding of the sun, where changing conditions can propagate out into the solar system, affecting Earth and other worlds. Parker Solar Probe will travel through the sun's atmosphere, closer to the surface than any spacecraft before it— and ultimately providing humanity with the closest-ever observations of a star.
- **Goals:** The primary science goals for the mission are to trace how energy and heat move through the solar corona and to explore what accelerates the solar wind as well as solar energetic particles.

Parker Solar Probe has three detailed science objectives:

- Trace the flow of energy that heats and accelerates the solar corona and solar wind.
- Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
- Explore mechanisms that accelerate and transport energetic particles.

Why study corona?

- The **corona is hotter than the surface of the sun. The corona gives rise to the solar wind**, a continuous flow of charged particles that permeates the solar system. Unpredictable solar winds cause disturbances in our planet's magnetic field and can play havoc with communications technology on Earth. Nasa hopes the findings will enable scientists to forecast changes in Earth's space environment.

19. PUNCH (Polarimeter to Unify the Corona and Heliosphere) Mission

- NASA has selected an US based Indian researcher to lead its **PUNCH mission which will image the Sun.**
- About PUNCH (Polarimeter to Unify the Corona and Heliosphere):
- It is focused on **understanding the transition of particles from the Sun's outer corona to the solar wind that fills interplanetary space.**
- It will **consist of a constellation of four microsatellites** that through continuous 3D deep-field imaging, will observe the corona and heliosphere as elements of a single, connected system.
- The **mission is expected to be launched in 2022.**

20. Launch Abort System (LAS)

- **NASA** recently carried out a successful test of a **launch-abort system** for the Orion capsule designed to take U.S. astronauts to the Moon.

About Launch Abort System (LAS):

- It is designed to **activate in the event of a rocket malfunction, on the pad or in flight.**
- The LAS **consists of three different types of solid-fuel rocket motors** that will work in synchrony with one another.
- In case of a launch-pad or in-flight failure, the abort tower rocket provides 400,000 pounds of thrust, pulling the crew capsule away.

Background:

- The Orion spacecraft is a major component of NASA's **Artemis program**, which aims to return U.S. astronauts to the lunar surface in 2024.

21. Artemis programme

Artemis- Acceleration, Reconnection, Turbulence and Electrodynamics of Moon's Interaction with the Sun.

It is **NASA's next mission to the Moon.**

The project is carried out in **collaboration with European Space Agency, Canadian Space Agency, Japan Space Agency and Australian Space Agency.**

Objective: To measure what happens when the Sun's radiation hits our rocky moon, where there is no magnetic field to protect it.

Artemis was **the twin sister of Apollo and goddess of the Moon in Greek mythology.**

Significance of the mission:

With the Artemis program, **NASA will land the first woman and next man on the Moon by 2024.**

Mission details:

NASA's powerful new rocket, **the Space Launch System (SLS)**, will send astronauts aboard **the Orion spacecraft** nearly a quarter million miles from Earth to lunar orbit.

- Astronauts will dock Orion at the Gateway and transfer to a human landing system for expeditions to the surface of the Moon.
- They will return to the orbital outpost to board Orion again before returning safely to Earth.

Artemis 1, 2 and 3:

The agency will fly **two missions around the Moon to test its deep space exploration systems.**

NASA is working toward launching **Artemis I**, an uncrewed flight to test the SLS and Orion spacecraft together, followed by the **Artemis II** mission, the first SLS and Orion test flight with crew.

NASA will land astronauts on the Moon by 2024 on the **Artemis III** mission and about once a year thereafter.

Scientific objectives:

- Find and use water and other critical resources needed for long-term exploration.
- Investigate the Moon's mysteries and learn more about our home planet and the universe.
- Learn how to live and operate on the surface of another celestial body where astronauts are just three days from home.
- Prove the technologies we need before sending astronauts on missions to Mars, which can take up to three years roundtrip.

Lunar missions- key facts:

- Before the US sent the Apollo 11 mission to the Moon, it sent **three classes of robotic missions between 1961 and 1968.**
- On July 20, 1969, **Neil Armstrong became the first human to step on the Moon as part of the Apollo 11 mission.**
- After July 1969, **12 American astronauts walked on the surface of the Moon until 1972.**
- In 1959, the Soviet Union's uncrewed **Luna 1 and 2 became the first rover to visit the Moon. Since then, seven nations have followed suit.**
- In the 1990s, the US resumed lunar exploration with **robotic missions Clementine and Lunar Prospector.**
- In 2009, it began a new series of robotic lunar missions with the launch of **the Lunar Reconnaissance Orbiter (LRO) and the Lunar Crater Observation and Sensing Satellite (LCROSS).**
- In 2011, NASA began the **ARTEMIS (Acceleration, Reconnection, Turbulence, and Electrodynamics of the Moon's Interaction with the Sun) mission** using a pair of repurposed spacecraft and in 2012 **the Gravity Recovery and Interior Laboratory (GRAIL) spacecraft** studied the Moon's gravity.
- Apart from the US, the European Space Agency, Japan, China, and India have sent missions to explore the Moon.
- China landed two rovers on the surface, which includes **the first-ever landing on the Moon's far side in 2019.**
- The **Indian Space Research Organisation (ISRO) recently announced India's third lunar mission Chandrayaan-3**, which will comprise a lander and a rover.

22. Lunar Reconnaissance Orbiter (LRO)

ISRO attempted to figure out what happened to **Chandrayaan-2's Vikram** with the help of NASA's Lunar Reconnaissance Orbiter (LRO).

LRO is a **NASA mission to the moon** within **the Lunar Precursor and Robotic Program (LPRP)** in preparation for future manned missions to the moon and beyond (Mars).

LRO is **the first mission of NASA's 'New Vision for Space Exploration'.**

The objectives of LRO are to:

- Identify potential lunar resources.
- Gather detailed maps of the lunar surface.
- Collect data on the moon's radiation levels.
- Study the moon's polar regions for resources that could be used in future manned missions or robotic sample return missions.
- Provide measurements to characterize future robotic explorers, human lunar landing sites and to derive measurements that can be used directly in support of future Lunar Human Exploration Systems.

23. NASA TO LAUNCH DRAGONFLY

- NASA plans to launch an unmanned nuclear-powered drone, Dragonfly as early as 2026 to search for life on Saturn's largest moon, Titan.

Key facts:

- Dragonfly **aims to search for signs of microbial alien life on Saturn's moon Titan**, while navigating its earth-like gravity and aerodynamics in the process.
- The mission will **succeed NASA's Cassini probe**, which ended its 13-year mission orbiting Saturn in September 2017 by diving into Saturn's atmosphere.
- Dragonfly mission is a **part of NASA's New Frontiers program**, which includes a series of space exploration missions, which are being conducted with the purpose of researching several of the Solar System bodies, including the dwarf planet Pluto.
- **The New Frontiers programme also includes** Pluto probe New Horizons, Jupiter probe Juno and OSIRIS-Rex asteroid mission.
- The Dragonfly mission **replaces a previously discontinued concept project called Titan Saturn System Mission (TSSM)**, which required a balloon probe to circumnavigate Titan.

Why study Titan?

- Titan is an analog to the very early Earth, and can provide clues to how life may have arisen on our planet.
- **Titan is larger than the planet Mercury and is the second largest moon in our solar system.**
- Because it is so far from the Sun, its surface temperature is around -290 degrees Fahrenheit (-179 degrees Celsius). Its surface pressure is also 50 percent higher than Earth's.

Objectives of the mission:

- Explore diverse environments from organic dunes to the floor of an impact crater where liquid water and complex organic materials key to life once existed together for possibly tens of thousands of years.
- Study how far prebiotic chemistry may have progressed.
- Investigate the moon's atmospheric and surface properties and its subsurface ocean and liquid reservoirs.
- Search for chemical evidence of past or extant life.

24. OSIRIS-Rex

- NASA has announced that its asteroid probe **OSIRIS-REx set a new record for the closest-ever orbit of a planetary body made by a man-made spacecraft.**
- The recent maneuver has placed the spacecraft into an orbit 680 meters above the asteroid Bennu's surface for about seven weeks.

About the mission:

- OSIRIS-Rex stands for **Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer.**
- OSIRIS-REx is the third mission in **NASA's New Frontiers program**, which previously sent the New Horizons spacecraft zooming by Pluto and the Juno spacecraft into orbit around Jupiter.

Why was Bennu chosen?

- **Proximity to Earth:** In order for OSIRIS-REx to reach its destination in a reasonable timeframe, NASA needed to find an asteroid which had a similar orbit to Earth.
- **Size:** Small asteroids, those less than 200m in diameter, typically spin much faster than larger asteroids, meaning the regolith material can be ejected into space. Bennu is around 500m in diameter, so rotates slowly enough to ensure that the regolith stays on its surface.
- **Composition:** Bennu is a primitive asteroid, meaning it hasn't significantly changed since the beginning of the Solar System (over 4 billion years ago). It is also very carbon-rich, meaning it may contain organic molecules, which could have been precursors to life on Earth.
- Additionally, Bennu is of interest as it is a **Potentially Hazardous Asteroid (PHA).**

25. Thirty Meter Telescope (TMT)

India, a partner in the construction of one of the largest telescopes in the world, TMT, has said **it wants the project to be moved out of the proposed site at Mauna Kea, a dormant volcano in Hawaii.**

About TMT:

The Thirty Meter Telescope (TMT) is an astronomical observatory with **an extremely large telescope (ELT).**

It is an international project being **funded by scientific organisations of Canada, China, India, Japan and USA.**

Planned location: Mauna Kea on the island of Hawaii in the US state of Hawaii.

Purpose: The TMT is designed for near-ultraviolet to mid-infrared observations, featuring adaptive optics to assist in correcting image blur.

Significance:

- TMT will enable scientists to study fainter objects far away from us in the Universe, which gives information about early stages of evolution of the Universe.
- It will give us finer details of not-so-far-away objects like undiscovered planets and other objects in the Solar System and planets around other stars.

About 70% of Indian contribution to **the Thirty Meter Telescope (TMT)** will be in the form of both hardware and software for the telescope. Indian entities are engaged in developing observatory software as well as telescope control system.

SIMPLIFYING IAS EXAM PREPARATION

26. Spitzer space telescope

Spitzer space telescope of NASA retired on January 30, 2020. Spitzer was shut down permanently after about 16 years of exploring the cosmos in infrared light.

Background:

Launched into solar orbit on August 25, 2003, Spitzer was initially scheduled for a minimum 2.5-year primary mission. But the space telescope has lasted far beyond its expected lifetime.

Key achievements:

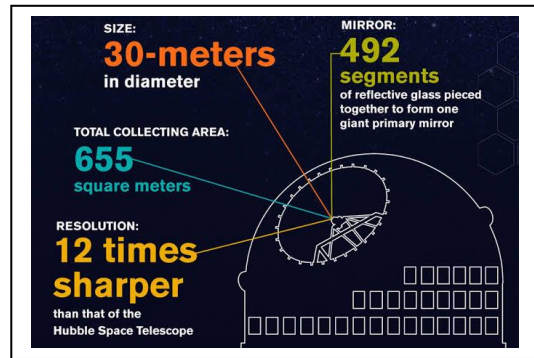
- Spitzer's discoveries extend from our own planetary backyard, to planets around other stars, to the far reaches of the universe.
- Spitzer has logged over 106,000 hours of observation time in the past 15 years. It has illuminated some of the oldest galaxies in the universe, revealed a new ring around Saturn, and peered through shrouds of dust to study newborn stars and black holes.
- The telescope also assisted in the discovery of planets beyond our solar system, including the detection of seven Earth-size planets orbiting the star **TRAPPIST-1**, among other accomplishments.

About Spitzer:

NASA's Spitzer Space Telescope was launched in 2003 **to study the universe in the infrared.**

It is the **last mission of the NASA Great Observatories program**, which saw **four specialized telescopes (including the Hubble Space Telescope) launched between 1990 and 2003.**

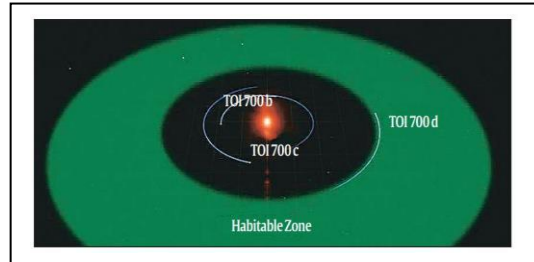
The goal of the Great Observatories is to observe the universe in distinct wavelengths of light.



The other observatories in **Greta Observatories Program** looked at visible light (Hubble, still operational), gamma-rays (Compton Gamma-Ray Observatory, no longer operational) and X-rays (the Chandra X-Ray Observatory, still operational).

27. Habitable Zone

- The habitable zone (or “Goldilocks zone”) is the range of orbital distances from a star at which liquid water can exist on the surface of a planet.
- It is the area around a star where it is not too hot and not too cold for liquid water to exist on the surface of surrounding planets.
- This range of distances changes depending on the size and temperature of the star.
- Earth is in the habitable zone of the sun – one of the reasons our planet has liquid water like oceans and lakes.



Why in News?

NASA reported the discovery of an Earth-size planet, named TOI 700 d, orbiting its star in the “habitable zone”.

28. Accretion Burst Event

Astronomers have recently found that the funnelling of matter into a forming star happens at different rates over time, as per **the rotating disc of gas and dust theory**.

Sometimes the forming star swallows up a huge amount of matter, resulting in a burst of activities in the massive star.

This is called **an accretion burst event**.

It is incredibly rare: **only three such events have been observed**, out of all the billions of massive stars in the Milky Way.

Need for these understandings:

Astronomers don't yet fully understand how massive stars in our galaxy are formed. So far, observations have only yielded some pieces of the puzzle.

This is because nearly all the known massive stars in our galaxy are located very far away from our solar system. They also form in close proximity to other massive stars, making it difficult to study the environment where they take shape.

So, **rotating disc theory helps in understanding these events**.

With this, the astronomers will be able **to develop and test theories to explain how high-mass stars gain their mass**.

Maser Monitoring Organisation (M2O):

After the **first detection of an accretion burst**, in 2016, astronomers from around the world agreed in 2017 to coordinate their efforts to observe more.

This led to the formation of **the Maser Monitoring Organisation (M2O)**.

The primary goal of M2O is **to make the astronomy community aware of the importance of Maser monitoring**. It is also to increase the number of sources monitored, the number of transitions monitored at, and increase cadence of observation.

What is a Maser?

A maser is **the microwave (radio frequency) equivalent of laser**. The word stands for “microwave amplification by stimulated emission of radiation”.

- Masers are **observed using radio telescopes** and most of them are observed at centimetre wavelength: they are very compact.
- A maser flare **can be a sign of an extraordinary event such as the formation of a star**.

29. SnowEx

NASA has launched a seasonal campaign — part of a five-year programme called **SnowEx**, initiated in 2016-17.

What is SnowEx?

It is **a five-year program initiated and funded by NASA**.

Objective: To address the most important gaps in snow remote sensing knowledge and thus lay the groundwork for a future snow satellite mission.

It focuses on airborne campaigns and field work, and on comparing the various sensing technologies, from the mature to the more experimental, in globally-representative types of snow.

The mission will utilize **a suite of airborne instruments such as Lidar, SAR, Passive Microwave, Multi-spectral/hyperspectral VIS/IR, and others, as well as ground measurements, to study Snow Water Equivalent (SWE) in forested areas.**

What are the SnowEx outcomes and International Engagement?

SnowEx will provide key insights into optimal strategies for mapping global SWE with remote sensing and models, which will enable a competitive proposal for **a Decadal Survey “Earth System Explorer” mission**.

The systematic assessment of methods for mapping water and energy components of seasonal snow in SnowEx is fully aligned with the objectives of **the NASA Terrestrial Hydrology Program and the Earth Science Division as well as the ESDS.**

30. Hera mission

The European Space Agency (ESA) had approved the budget of **Hera**, the European component of the mission to slam a spacecraft into an asteroid.

What is Hera?

Hera is **the European contribution to an international double-spacecraft collaboration**.

Hera is **named after the Greek goddess of marriage**.

How is it planned?

Due **to launch in 2024**, Hera would travel to a binary asteroid system – the **Didymos** pair of near-Earth asteroids.

NASA will first perform a kinetic impact on the smaller of the two bodies, then **Hera will follow-up with a detailed post-impact survey** that will turn this grand-scale experiment into a well-understood and repeatable planetary defence technique.

What is DART mission?

Double Asteroid Redirection Test (DART) will target Didymoon as part of its **planetary defence programme**.

- DART will deliberately **crash itself into the moonlet** at a speed of approximately 6 km per second, using an onboard camera and autonomous navigation software.
- The collision will **change the speed of the moonlet in its orbit around the main body**.

Why Didymoon?

- Didymoon was chosen because of **its close proximity to Earth and its size**. Didymoon is **small and in a tight enough 12-hour orbit around its parent**, that its orbital period can indeed be shifted in a measurable way.

Significance:

- DART and Hera were conceived together as part of the international '**Asteroid Impact Deflection Assessment**' experiment.

Why we need a planetary defence mechanism?

- There are around 25,000 near-Earth objects (NEOs) that orbit the Sun on a trajectory that brings them close to our planet's orbit. Certain near-Earth objects have been classified as "potentially hazardous".
- As of now, there are about 900 near-Earth objects measuring more than 1 km. An impact from one of these NEOs can bring devastating effects to Earth.
- That is why scientists are working on a number of planetary protection initiatives to deflect asteroids if they threaten to impact the Earth.

31. Starlink network project

Starlink is a satellite constellation being constructed by American company SpaceX to provide **satellite Internet access**. The constellation will consist of thousands of mass-produced small satellites in low Earth orbit (LEO), working in combination with ground transceivers.

Significance of the project:

The project ensures that reliable and uninterrupted Internet services are universally available in every part of the globe.

- Currently, about 4 billion people, more than half the world's population, do not have access to reliable Internet networks.
- And that is because **the traditional ways to deliver the Internet — fibre-optic cables or wireless networks — cannot take it everywhere on Earth.**
- In many remote areas, or places with difficult terrain, it is not feasible or viable to set up cables or mobile towers.

Signals from satellites in space can overcome this obstacle easily.

Why use low earth orbit instead of geostationary?

Geostationary orbit is **located at a height of 35,786 km over the Earth's surface**, directly above the Equator. Satellites in this orbit move at speeds of about 11,000 km per hour, and complete one revolution of the Earth in the same time that the earth rotates once on its axis. To the observer on the ground, therefore, a satellite in geostationary orbit appears stationary.

Advantages: Signals from geostationary orbit can cover a very large part of the Earth. Signals from one satellite can cover roughly a third of the planet — and three to four satellites would be enough to cover the entire Earth. Also, because they appear to be stationary, it is easier to link to them.

Then what's the issue?

There is **a time lag — called latency** — between a user seeking data, and the server sending that data.

And because data **transfers cannot happen faster than the speed of light** (in reality, they take place at significantly lower speeds), the longer the distance that needs to be covered the greater is the time lag, or latency.

A transmission from a **satellite in geostationary orbit has a latency of about 600 milliseconds.**

How low earth orbit seeks to solve this issue?

A satellite in the lower orbit, 200-2,000 km from the Earth's surface, can bring the lag down to 20-30 milliseconds, roughly the time it takes for terrestrial systems to transfer data.

Concerns over LEOs:

Owing to their lower height, **their signals cover a relatively small area**. As a result, many more satellites are needed in order to reach signals to every part of the planet.

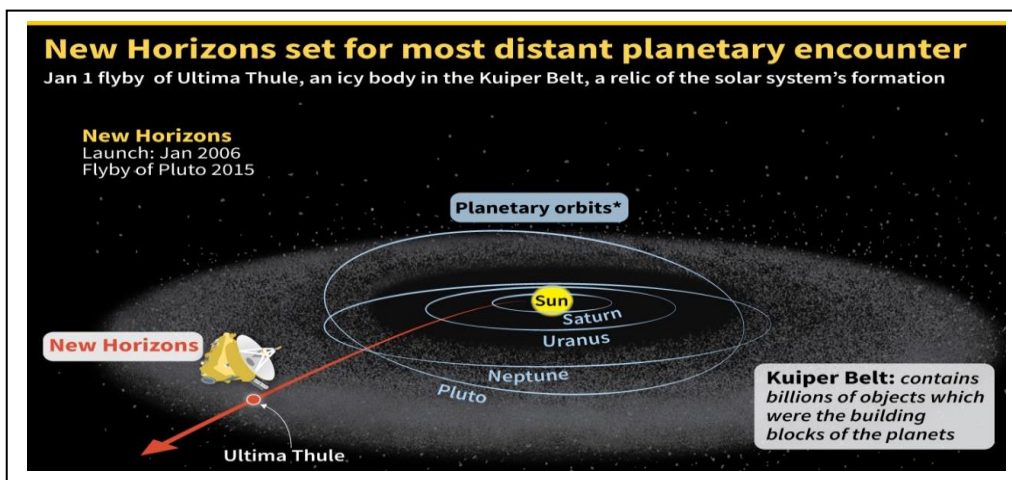
Other issues include: Increased space debris, increased risk of collisions, and the concern of astronomers that these constellations of space Internet satellites will make it difficult to observe other space objects, and to detect their signals.

32. NASA renames Ultima Thule to 'Arrokoth'

National Aeronautics and Space Administration (NASA) has recently renamed farthest cosmic body, earlier known as '**Ultima Thule**' to '**Arrokoth**' or **Sky**.

The old name attracted controversy because **the word 'Thule' has been associated with Nazis in the past**.

- On January 1 2019, **NASA's New Horizons spacecraft became the first explorer to fly past the mysterious object- Ultima Thule**, located some 4 billion miles from Earth.
- This is a historic flyby of the farthest, and quite possibly the oldest, cosmic body ever explored by humankind.

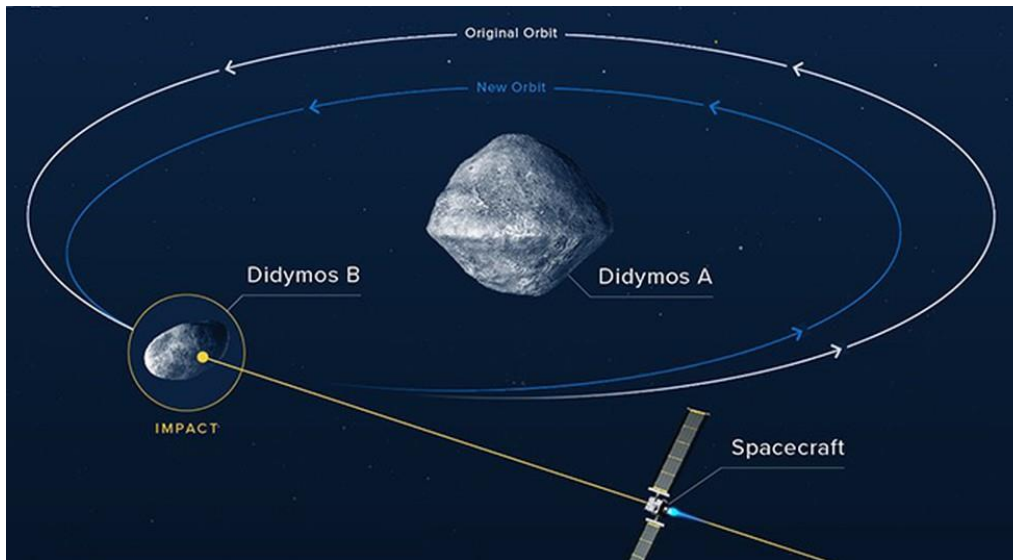


- **Key facts- Ultima Thule (now Arrokoth):**
 - Ultima Thule is **located in the Kuiper belt** in the outermost regions of the Solar System, beyond the orbit of Neptune.
 - It measures approximately 30 km in diameter, and is irregularly shaped.
 - Ultima Thule has a reddish color, probably caused by exposure of hydrocarbons to sunlight over billions of years.
 - **Ultima Thule belongs to a class of Kuiper belt objects called the "cold classicals"**, which have nearly circular orbits with low inclinations to the solar plane.
- **Background:**
 - New Horizons was launched on 19 January 2006, and has been travelling through space for the past nine years.
 - New Horizon's core science mission is to map the surfaces of Pluto and Charon, to study Pluto's atmosphere and to take temperature readings.
- **Facts for Prelims:**
 - **The Kuiper belt** sometimes called the Edgeworth–Kuiper belt, is a region of the Solar System beyond the planets, extending from the orbit of Neptune (at 30 AU) to approximately 50 AU from the Sun.
 - It is similar to the asteroid belt, but it is far larger—20 times as wide and 20 to 200 times as massive.

33. Asteroid Impact Deflection Assessment (AIDA)

- Asteroid Impact Deflection Assessment (AIDA) is a joint research mission between NASA and the European Space Agency (ESA) teams.

- It aims to **study the viability of diverting an asteroid by crashing a spacecraft into its surface.**
- The project aims to **deflect the orbit of one of the two Didymos asteroids** between Earth and Mars, with an observer craft gauging the effect of the impact more effectively than ground-based observers could manage.



34. NASA's Kepler Space Telescope

- The National Aeronautics and Space Administration's (NASA) **Transiting Exoplanet Survey Satellite (TESS)** has discovered a new planetary system called **TESS Object of Interest (TOI) 270.**
- **Where is it located?** TOI 270 is about 73 light years away from Earth, and is located in the constellation **Pictor** (Pictor is a constellation in the southern celestial hemisphere).

About TESS mission:

- The Transiting Exoplanet Survey Satellite (TESS) is a **NASA mission** that will look for planets orbiting the brightest stars in Earth's sky. It was led by the Massachusetts Institute of Technology with seed funding from Google.
- **Mission:** The mission will monitor at least 200,000 stars for signs of exoplanets, ranging from Earth-sized rocky worlds to huge gas giant planets. TESS, however, will focus on stars that are 30 to 100 times brighter than those Kepler examined. This will help astronomers better understand the structure of solar systems outside of our Earth, and provide insights into how our own solar system formed.
- **Orbit:** TESS will occupy a never-before-used orbit high above Earth. The elliptical orbit, called P/2, is exactly half of the moon's orbital period; this means that TESS will orbit Earth every 13.7 days.
- **How it works?** It will use transit method to detect exoplanets. It watches distant stars for small dips in brightness, which can indicate that planet has passed in front of them. Repeated dips will indicate planet passing in front of its star. This data has to be validated by repeated observations and verified by scientists.

35. Copernicus Programme

- Copernicus is the most ambitious **Earth observation programme.**
- It will provide accurate, timely and easily accessible information to improve the management of the environment, understand and mitigate the effects of climate change and ensure civil security.
- Copernicus is **the new name for the Global Monitoring for Environment and Security programme, previously known as GMES.**

- This initiative is **headed by the European Commission (EC) in partnership with the European Space Agency (ESA)**.
- **Services provided by Copernicus:** land management, the marine environment, atmosphere, emergency response, security and climate change.
- **Sentinel:** ESA is developing a new family of satellites, called Sentinels, specifically **for the operational needs of the Copernicus programme**. The Sentinels will provide a unique set of observations, starting with the all-weather, day and night radar images.

36. Saturn is the planet with the highest number of moons

Recently the discovery of 20 new moons of Saturn has made Saturn **the planet with the highest number of moons (82)**.

- **The previous record- holder, Jupiter, has 79.**
- This was announced by **the International Astronomical Union's Minor Planet Center**.
- Of Saturn's 20 newfound moons, 17 are retrograde, meaning they orbit in the opposite direction that Saturn rotates. Three orbit in the same direction that Saturn spins. Two of those prograde moons orbit fairly close to the planet while one oddball is farther out.

37. Meteor showers

Meteors are bits of rock and ice that are ejected from comets as they manoeuvre around their orbits around the sun.

Meteor showers, on the other hand, are witnessed when Earth passes through the trail of debris left by a comet or an asteroid. When a meteor reaches the Earth, it is called a **meteorite** and a series of **meteorites** when encountered at once, is termed as a meteor shower.

38. METHANE-POWERED ROCKET ENGINE

- ISRO is developing two '**LOx methane**' engines (**liquid oxygen oxidiser and methane fuel**) engines.

Why use methane?

- Methane, which can be **synthesised with water and carbon dioxide** in space, is often **described as the space fuel of the future**.
- **Unsymmetrical Di-Methyl Hydrazine, along with Nitrogen tetroxide for oxidiser**, currently being used by ISRO, is said to be highly toxic and cancer-causing.
- Whereas Methane, apart from being **non-toxic**, has a **higher specific impulse** (which means one kg of the gas can lift one kg of mass for a longer time), it is **easy to store**, does **not leave a residue upon burning**, less bulky, and, importantly, can be **synthesised up in space**.

39. Project NETRA

- ISRO has initiated '**Project NETRA**' – an early warning system in space to detect debris and other hazards to Indian satellites.

Significance of the project:

- The project will give India its own capability in **space situational awareness (SSA)** like the other space powers — which is used to 'predict' threats from debris to Indian satellites.
- NETRA's eventual goal is to capture the GEO, or geostationary orbit, scene at 36,000 km where communication satellites operate.
- The effort would make India a part of international efforts towards tracking, warning about and mitigating space debris.

What is Project NETRA (Network for space object Tracking and Analysis)?

- Under the project, the ISRO plans to put up many observational facilities: connected radars, telescopes; data processing units and a control centre.
- They can, among others, spot, track and catalogue objects as small as 10 cm, up to a range of 3,400 km and equal to a space orbit of around 2,000 km.

40. SAGITTARIUS A*

- It is a **supermassive black hole** 26,000 light years away from Earth, near the Galactic Centre, or the centre of the Milky Way.
- Why in News? In recent years, it has shown unusual activity, and the area around it has been much brighter than usual.

Possible reasons for this:

- It may be that the Sagittarius A* has become hungrier, and has been feeding on nearby matter at a markedly faster rate, described as a **“big feast”**.
- It **could be growing faster than usual in size**, or that the current model that measures its level of brightness is inadequate and is in need of an update.
- **A black hole does not emit light by itself, but the matter that it consumes can be a source of light.** A large quantity of gas from the S0-2 star, which travelled close to the black hole last year, may now have reached the latter.

41. INTERPLANETARY POLLUTION

- On April 11, 2019 the **Israeli spacecraft Beresheet** attempted to land on the Moon, but crashed on the surface. It was carrying a number of items — including thousands of specimens of a living organism called **tardigrade**.

What are Tardigrades?

- The tardigrade, also known as **water bear**, is among the toughest and most resilient creatures on Earth.
- The tardigrade **can only be seen under a microscope**.
- Half a millimetre long, it is essentially a **water-dweller** but also inhabits land and, a 2008 study found, **can survive in the cold vacuum of outer space**.
- The tardigrade **can endure extreme hot and cold temperature levels**.
- They themselves expel water from their bodies and set off a mechanism to protect their cells, and can still revive if placed in water later. The organism is known to **“come back to life” on rehydration**.
- The tardigrade derives its name from the fact that **it looks like an eight-legged bear**, with a mouth that can project out like a tongue.
- A tardigrade typically eats fluids, using its claws and mouth to tear open plant and animal cells, so that it can suck nutrients out of them.
- It is also known to feast on bacteria and, in some cases, to kill and eat other tardigrades.

Beresheet:

- Israel's First Lunar Lander- **Beresheet**– was launched on board Falcon 9.
- Beresheet attempted **to become the first Israeli spacecraft**, and the **first privately-operated mission**, to land on the Moon.



42. Magnetospheric Multiscale mission (MMS)

- The **Magnetospheric Multiscale mission (MMS)** had recently made the first precise measurements of an interplanetary shock using high-resolution instruments.
- These interplanetary shocks provide ideal test beds for learning about larger universal phenomena. About Magnetospheric Mission:

- NASA's MMS investigates **how the Sun's and Earth's magnetic fields connect and disconnect**, explosively transferring energy from one to the other in a process that is important at the Sun, other planets, and everywhere in the universe, known as **magnetic reconnection**.
- **Reconnection limits the performance of fusion reactors and is the final governor of geospace weather** that affects modern technological systems such as telecommunications networks, GPS navigation, and electrical power grids.

43. FEDOR

- Russia had launched an unmanned rocket into space.
- It carried a **life-size humanoid robot** that spent 10 days learning to assist astronauts on the International Space Station.
- Known as **FEDOR**, which stands for **Final Experimental Demonstration Object Research**, the Skybot F-850 is the **first humanoid robot to be sent to space by Russia**.
- The robot's main purpose is to be used in operations that are especially dangerous for humans onboard spacecraft and in outer space.
- FEDOR, who is the size of an adult and **can emulate movements of the human body, has apparently embraced**
- his mission, describing himself as "an assistant to the ISS crew".

Background:

- Fedor is not the first robot to go into space.
- In 2011, NASA sent up **Robonaut 2**, a humanoid robot developed with General Motors that had a similar aim of working in high-risk environments.
- In 2013, Japan sent up a small robot called **Kirobo** along with the ISS's first Japanese space commander.

44. Gravitational Lensing

- Using NASA's **James Webb Space Telescope** as a sort of time machine, researchers plan to investigate how new stars are born, with the help of a natural phenomenon called "**gravitational lensing**".

What is gravitational lensing? How it works?

- Gravitational lensing is an effect of Einstein's theory of **general relativity** – simply put, **mass bends light**.
- The gravitational field of a massive object will extend far into space, and cause light rays passing close to that object (and thus through its gravitational field) to be bent and refocused somewhere else.
- **The more massive the object, the stronger its gravitational field** and hence the greater the bending of light rays – just like using denser materials to make optical lenses results in a greater amount of refraction.

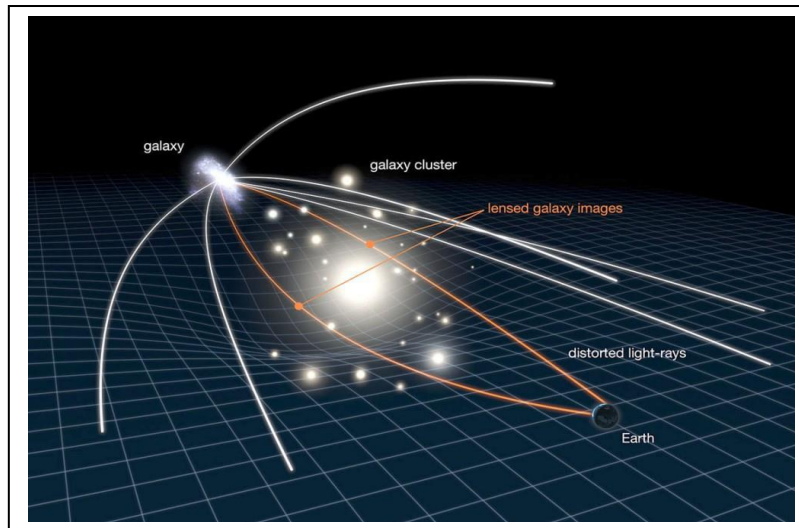
Why is lensing useful?

- Gravitational lensing is useful to cosmologists because **it is directly sensitive to the amount and distribution of dark matter**.
- Lensing can help astronomers work out exactly how much dark matter there is in the Universe as a whole and also how it is distributed.
- Lensing has also been used to help verify the existence of dark matter itself.

What is the James Webb Space Telescope?

- The James Webb Space Telescope, also called Webb or JWST, is a large, space-based observatory, optimized for infrared wavelengths, which will complement and extend the discoveries of the Hubble Space Telescope.

- It will cover longer wavelengths of light than Hubble and will have greatly improved sensitivity.
- The longer wavelengths enable JWST to look further back in time to see the first galaxies that formed in the early universe, and to peer inside dust clouds where stars and planetary systems are forming today.



Why is Webb an infrared telescope?

- By viewing the universe at infrared wavelengths Webb will show us things never before seen by any other telescope. **It is only at infrared wavelengths that we can see the first stars and galaxies forming after the Big Bang.** And it is with infrared light that we can see stars and planetary systems forming inside clouds of dust that are opaque to visible light.

45. MARS SOLAR CONJUNCTION

- During Mars solar conjunction, **Mars and Earth will be on opposite sides of the Sun.**
- The Sun expels hot, ionised gas from its corona, which extends far into space.
- During solar conjunction, this gas can interfere with radio signals when engineers try to communicate with spacecraft at Mars, corrupting commands and resulting in unexpected behaviour from those space explorers.
- When Mars disappears far enough behind the Sun's corona that there is increased risk of radio interference, engineers hold off on sending commands.
- Solar conjunction occurs every two years.

46. Hayabusa2

- Japan's **Hayabusa2** spacecraft, which successfully made its second touchdown on asteroid Ryugu on July 12, 2019, has become **the first ever space probe to gather material from beneath the surface of an asteroid.**

Hayabusa:

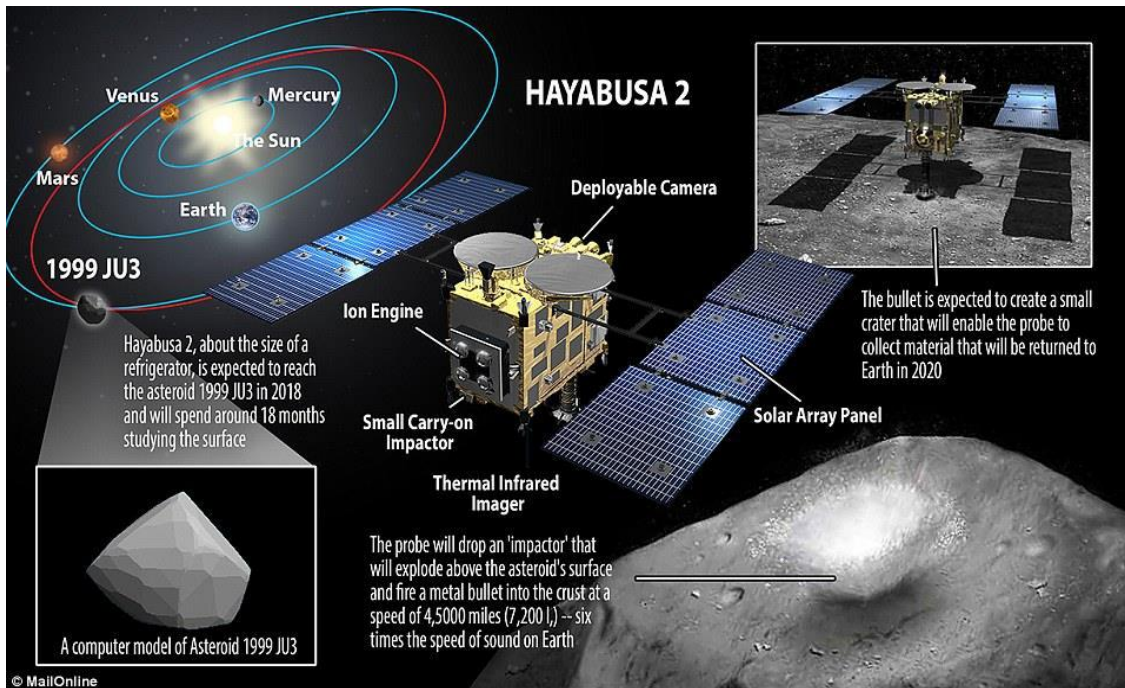
- In mid-September 2005, Hayabusa landed on the asteroid **Itokawa**, and managed to collect samples in the form of grains of asteroidal material. It returned to Earth with the samples in June 2010, thereby becoming **the first spacecraft to return asteroid samples to Earth for analysis.**

Hayabusa2:

- It is **an asteroid sample-return mission operated by the Japanese space agency, JAXA.**
- It was launched on 3 December 2014 and rendezvoused with **near-Earth asteroid 162173 Ryugu** on 27 June 2018.
- It is in the process of surveying the asteroid for a year and a half, departing in December 2019, and returning to Earth in December 2020.
- Hayabusa2 **carries multiple science payloads for remote sensing, sampling, and four small rovers** that will investigate the asteroid surface to inform the environmental and geological context of the samples collected.

What is the significance of the mission?

- **Ryugu** is a C-type asteroid – a relic from the early days of the Solar System. Scientists think that **C-type asteroids contain both organic matter, and trapped water, and might have been responsible for bringing both to Earth, thereby providing the planet with the materials necessary for life to originate.**

**47. Spektr- RG**

- **Spektr-RG** is a **Russian–German high-energy astrophysics space observatory** launched recently. It follows on from the Spektr-R satellite telescope launched in 2011.
- The **Spektrum-Röntgen-Gamma mission**, also known as **Spektr-RG**, is a **joint project between the Russian space agency, Roscosmos, and the German space agency, DLR.**
- **Objectives:** The spacecraft is expected to detect 100,000 galaxy clusters, 3 million supermassive black holes, tens of thousands of star-forming galaxies, the presence of plasma (superheated gas) and many more types of objects.
- A key goal of Spektr-RG will be **to investigate the mysterious cosmic components referred to as “dark matter” and “dark energy”.**

48. NASA'S INSIGHT SPACECRAFT

- Recently, NASA InSight mission detected quakes and magnetic pulses on the planet Mars.
- InSight is part of **NASA's Discovery Program**, managed by the agency's Marshall Space Flight Center in Huntsville, Alabama.
- It is the **first mission to peer deep beneath the Martian surface**, studying the planet's interior by measuring its heat output and listening for marsquakes, which are seismic events similar to earthquakes on Earth.
- It will use the seismic waves generated by **marsquakes** to develop a map of the planet's deep interior.

49. NASA's Curiosity rover

NASA's Curiosity rover recently discovered high amounts of **methane in the air on Mars**, leading to excitement whether this was an indication of life on the Red Planet, or beneath its surface. However, later it was confirmed that the methane had fallen back to usual levels.

What is Methane?

- On Earth, methane (CH₄) is a **naturally occurring gas**. **Most of the methane on Earth is produced in biological processes** — some of it by microbes, and **some occurring as underground natural gas** that had been formed by earlier generations of microbial life.
- Many of these methane-producing microbes live in the digestive systems of animals, especially cows.
- However, **methane can also be produced by abiotic processes** (those that do not involve living organisms).
- It has been found to **occur in formations** such as rocks, springs and aquifers, and studies have concluded that it was **formed there by chemical reactions between carbon and hydrogen atoms at low temperature**.
- Once it is released into the atmospheres of either Earth or Mars, **methane is relatively short-lived**.

NASA's Curiosity:

- Curiosity is a car-sized robotic rover exploring **Gale Crater** on Mars as part of NASA's Mars Science Laboratory mission (MSL).
- **The rover's goals include:** investigation of the Martian climate and geology; assessment of whether the selected field site inside Gale Crater has ever offered environmental conditions favorable for microbial life, including investigation of the role of water; and planetary habitability studies in preparation for future human exploration.

50.Chang'e-4

- **Chinese spacecraft Chang'e-4** — named after the moon goddess in Chinese mythology — became the first ever craft to touch down on the far side of the lunar surface.

Key findings:

- China landed its probe in the **Von Karmen Crater in the Aitken Basin** at the Moon's south pole — home to one of the largest impact craters known in the solar system.

About the mission:

- Chang'e 4 is the fourth mission in the country's lunar mission series which is being named after the Chinese moon goddess.
- The tasks of the Chang'e-4 probe include **low-frequency radio astronomical observation**, surveying the terrain and landforms, detecting the mineral composition, and measuring the neutron radiation and neutral atoms to study the environment on the far side of the moon.

Technologies / New Discoveries

1. Reverse osmosis (RO)

The Union Environment Ministry had issued a notification to comply with the NGT order which **prohibited the use of reverse osmosis (RO) purifiers in places where total dissolved solids (TDS) in the supplied water are below 500 mg per litre.**

The NGT had ordered a ban on RO filters on the grounds that **they wasted water and that, in the process of removing salts, they often deprived drinking water of essential salts**, which could affect the nutritional intake of the people.

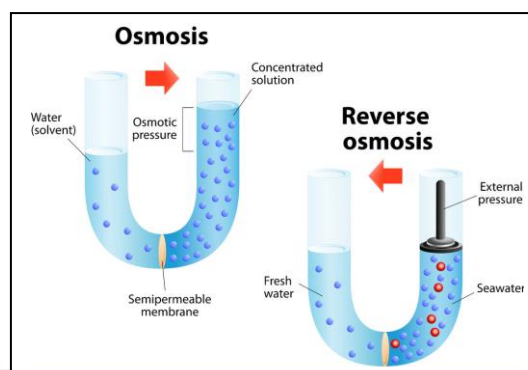
Background:

Current BIS regulations consider **500 mg/litre—1,200 mg/litre of total dissolved solids, which consist of salts and some organic matter, as acceptable.**

Osmosis and RO:

Osmosis involves 'a solvent (such as water) naturally moving from an area of low solute concentration, through a membrane, to an area of high solute concentration.

A **reverse osmosis** system applies an external pressure to reverse the natural flow of solvent and so seawater or brackish water is pressurised against one surface of the membrane, causing salt-depleted water to move across the membrane, releasing clean water from the low-pressure side'.



What are the problems with RO plants?

Deposition of brine (highly concentrated salt water) along the shores.

Affects fauna and flora: Hyper salinity along the shore affects plankton, which is the main food for several of these fish species. The high pressure motors needed to draw in the seawater end up sucking in small fish and life forms, thereby crushing and killing them — again a loss of marine resource.

Construction of the RO plants required troves of groundwater. Freshwater that was sucked out and is replaced by salt water, rendering it unfit for the residents around the desalination plants.

Cost and time: On an average, it costs about ₹900 crore to build a 100 MLD-plant and, as the Chennai experience has shown, about five years for a plant to be set up.

Energy needed: To remove the salt required, there has to be a source of electricity, either a power plant or a diesel or battery source. Estimates have put this at about 4 units of electricity per 1,000 litres of water. It is estimated that it cost ₹3 to produce 100 litres of potable water.

Is RO water healthy?

There are concerns that desalinated the RO water may be **short of vital minerals such as calcium, magnesium, zinc, sodium, potassium and carbonates.**

Most RO plants put the water through a **'post-treatment'** process whereby salts are added to make TDS around 300 mg/l.

Are there technological alternatives?

Low-temperature thermal desalination (LTTD) technique works on the principle that water in the ocean 1,000 or 2,000 feet below is about 4° C to 8° C colder than surface water. So, salty surface water is collected in a tank and subject to high pressure (via an external power source). This pressured water vapourises and this is trapped in tubes or a chamber. Cold water plumbed from the ocean depths is passed over these tubes and the vapour condenses into fresh water and the resulting salt diverted away.

Ocean Thermal Energy Conversion: It will draw power from the vapour generated as a part of the desalination process. This vapour will run a turbine and thereby will be independent of an external power source. While great in theory, there is no guarantee it will work commercially. For one, this ocean-based plant requires a pipe that needs to travel 50 kilometres underground in the sea before it reaches the mainland.

2. Quantum Technologies

Finance minister Nirmala Sitharaman's Union Budget for 2020-21, presented on February 1, 2020, proposed Rs 8,000 crore over five years for **National Mission on Quantum Technologies and Applications**.

What are Quantum Technologies?

Quantum technologies comprise quantum computing, quantum communication, quantum optics, quantum information processing, quantum internet and quantum artificial intelligence.

Need for special attention:

- The interest and excitement about quantum computer is because of its power to dabble with **complex calculations** involved in fields like cyber-security which digital computers now deal with.
- Quantum communications can **enhance (cyber) security**, provide unique fingerprints and also increase available bandwidth for internet networks.

What is a quantum computer?

- Quantum computers work by harnessing the properties of **quantum mechanics**.
- Quantum computers use logical units called **quantum bits, or qubits** for short, that can be put into a quantum state where **they can simultaneously represent both 0 and 1**.

Difference between classical and quantum computers?

- Classical computers process information in a binary format, called bits, which can represent either a 0 or 1.
- While the bits in a classical computer all operate independently from one another, in a quantum computer, the status of one qubit effects the status of all the other qubits in the system, so they can all work together to achieve a solution.

How the result is obtained?

While a conventional computer outputs the same answer to a problem every time you run a calculation, the outputs of a **quantum computer are probabilistic**. That means it does not always produce the same answer. So to use a quantum computer, you have to run a calculation through the system thousands or even millions of times, and the array of outputs converge around the answer that is most likely to be correct.

3. Quantum Supremacy

Google researchers claim to have achieved a major milestone in computer science known as "**quantum supremacy**."

They said their quantum system had executed a calculation in 200 seconds that would have taken a classic computer 10,000 years to complete.

What is quantum supremacy?

It means only that **researchers have been able to use a quantum computer to perform a single calculation that no conventional computer, even the biggest supercomputer, can perform in a reasonable amount of time**.

4. Muktoshri- arsenic-resistant rice

West Bengal government's rice research centre has come up with a new variety of rice called **Muktoshri** that can be grown in arsenic prone areas.

It was **developed jointly by** the Rice Research Station at Chinsurah, coming under West Bengal's Agriculture Department and the National Botanical Research Institute, Lucknow.

Background:

West Bengal has a high concentration of arsenic in groundwater, with 83 blocks across seven districts having higher arsenic levels than permissible limits.

Arsenic- Key facts:

Arsenic is **naturally present at high levels in the groundwater of a number of countries. It is also present in rocks and soils.**

Arsenic is **highly toxic in its inorganic form.**

Permissible limit:

World Health Organization's provisional guideline value for arsenic in drinking water is 0.01 mg/l (10 µg/l). The permissible limit of arsenic in India in the absence of an alternative source is 0.05 mg/l (50 µg/l).

Harmful effects:

- Contaminated water used for drinking, food preparation and irrigation of food crops poses the **greatest threat to public health** from arsenic.
- Long-term exposure to arsenic from drinking-water and food can cause **cancer and skin lesions.**
- It has also been associated with **cardiovascular disease and diabetes.**
- In utero and early childhood exposure has been linked to **negative impacts on cognitive development and increased deaths in young adults.**

What's the difference between organic arsenic and inorganic arsenic?

Atoms of arsenic bond with other elements to form molecules — if carbon is one of these elements, then the arsenic compound is an organic compound. If there is no carbon present, then the arsenic compound is in an inorganic compound.

Inorganic arsenic is a known human carcinogen — it is this form of arsenic that is linked with increased risks of cancer and other health effects.

5. World's most efficient lithium sulphur battery developed in Australia

Researchers at the University of Monash in Australia have managed to create a **super-capacity prototype by re-engineering a Lithium Sulphur (Li-S) battery.**

How it works?

The lithium-sulphur batteries operate in the same way as regular lithium-ion work- **lithium ions flow between electrodes producing power while not being chemically changed.** Charging a battery involves those ions being returned to their starting positions for the process to begin anew.

Significance:

This battery that has **five times the capacity of a traditional lithium ion battery.** It can retain 99 per cent of its charge even after 200 charge cycles.

Li-S batteries are also **many times cheaper than lithium ion batteries that could bring down the cost of electric mobility.**

6. Iron Ion Battery

- **IIT Madras** has fabricated a **rechargeable iron ion battery** and registered initial success.
- The iron ion battery is **cost-effective** and **the amount of energy that can be stored in the battery is also high**.

Benefits of iron over Lithium:

- Iron has **favourable physico-chemical properties** like lithium.
- The **redox potential of iron ion is higher than lithium ion** and the radius of the Fe²⁺ ion is nearly the same as that of the lithium ion.
- **Iron is more stable during the charging process** and therefore **prevents short-circuiting of the batteries**. This, when compared with the popular lithium metal-based batteries helps cut down the cost and make it safer to handle.

7. Laser Interferometer Gravitational Wave Observatory (LIGO) project

An international team led by LIGO-Virgo scientists has identified another event of gravitational ripples from **a collision of two neutron stars**, making it the second time this type of occurrence has ever been observed in gravitational waves.

Background:

In August 2017, the first observation of gravitational ripples from a neutron star collision made history for being the first time that both gravitational waves and light were detected from the same cosmic occurrence.

What is LIGO?

It is a massive observatory for detecting **cosmic gravitational waves and for carrying out experiments**.

The objective is to use gravitational-wave observations in astronomical studies.

The project operates **three gravitational-wave (GW) detectors**. Two are at Hanford, Washington, north-western US, and one is at Livingston in Louisiana, south-eastern US.

The proposed **LIGO India project aims to move one advanced LIGO detector from Hanford to India**.

About LIGO- India project:

It is piloted by **Department of Atomic Energy (DAE) and Department of Science and Technology (DST)**.

The LIGO-India project will be **jointly coordinated and executed by three Indian research institutions**: the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune and Department of Atomic Energy organisations: Institute for Plasma Research (IPR), Gandhinagar and the Raja Ramanna Centre for Advanced Technology (RRCAT), Indore.

Benefits for India:

1. The project will bring unprecedented opportunities for scientists and engineers to dig deeper into the realm of gravitational wave and take global leadership in this new astronomical frontier.
2. The LIGO-India project will also bring considerable opportunities in cutting-edge technology for the Indian industry which will be engaged in the construction of the eight-km long beam tube at ultra-high vacuum on a levelled terrain.
3. With its establishment, India will join the global network of gravitational wave detectors.

What are Gravitational Waves?

- Gravitational waves are the ripples in the pond of spacetime. The gravity of large objects warps space and time, or "spacetime" as physicists call it, the way a bowling ball changes the shape of a trampoline as it rolls around on it.
- Smaller objects will move differently as a result – like marbles spiraling toward a bowling-ball-sized dent in a trampoline instead of sitting on a flat surface.

- Establishing an observatory in India also assumes importance because the further the distance between the observatories, the greater will be the accuracy in locating gravity waves.

8. Hyperloop

What is hyperloop transportation system?

It is a **transportation system where a pod-like vehicle is propelled through a near-vacuum tube** connecting cities at speeds matching that of an aircraft.

The hyperloop concept is a brainchild of Tesla founder **Elon Musk**.

How it operates?

- In hyperloop transportation, custom-designed capsules or pods are expected to zip smoothly through continuous steel tubes which are held at partial vacuum.
- The pod which sandwiches the passenger compartment between an air compressor upfront and a battery compartment in the rear is supported by air caster skis at the bottom.
- The skis float on a thin layer of air provided under high pressure, eliminating rolling resistance and allowing for movement of the pods at high speeds.
- These capsules are expected to be driverless with estimated speeds of 1,000 km/h. Linear induction motors that are placed along the tube control the speed of the pod. Electronically-assisted acceleration and braking determines the speed of the capsule.



9. Polycrack technology

The **country's first Government-owned Waste-to-Energy Plant** was recently commissioned at the Mancheswar Carriage Repair Workshop in **Odisha**.

The plant, a patented technology called **Polycrack**, is first-of-its-kind in the Indian Railways and fourth in the country. It **converts multiple feed stocks into hydrocarbon liquid fuels, gas, carbon and water**.

What is Polycrack?

It is **the world's very first patented heterogeneous catalytic process** which **converts multiple feedstocks into hydrocarbon liquid fuels, gas, carbon as well as water**.

- The waste generated will become the feeder material for the waste to energy plant.
- The energy which will be produced at the plant, will be in the form of light diesel oil and this oil will be used to light furnaces.



The plant, having a capacity of 500 kg per batch can be fed with the following:

- All kinds of existing plastic
- Petroleum sludge
- Un segregated MSW with moisture up to 50 per cent
- E-waste
- Automobile fluff
- Organic waste including bamboo, garden waste
- Jathropa fruit and palm bunch

10. Black Box in an airplane

Any commercial aeroplane or corporate jet is required to be equipped with **a cockpit voice recorder and a flight data recorder. It is these two items of separate equipment which we commonly refer to as a 'Black Box.'**

While they do nothing to help the plane when it is in the air, both these pieces of equipment are vitally important should the plane crash, as **they help crash investigators find out what happened just before the crash.**

To help locate the cockpit voice recorder and a flight data recorder in the aftermath of a plane crash that occurs at sea, each recorder has a device fitted to it known as **an Underwater Locator Beacon (ULB).** The device is activated as soon as the recorder comes into contact with water and it can transmit from a depth as deep as 14,000 feet. Also, to help investigators find them; **a Black Box is not actually black at all, but bright orange.**

11. 'Virtual human' NEONs

The **first project of Samsung's Star Labs, NEONs** are being called **the world's first artificial humans.**

What are they?

- NEONs are computationally created virtual humans — the word derives from NEO (new) + human.
- For now the virtual humans can show emotions when manually controlled by their creators.
- But the idea is for NEONs to become intelligent enough to be fully autonomous, showing emotions, learning skills, creating memories, and being intelligent on their own.



How do they work?

There are two core technologies behind his virtual humans.

- First, there is the proprietary **CORE R3 technology** that drives the “reality, real time and responsiveness” behind NEONs.
- The next stage will be **SPECTRA**, which will complement CORE R3 with the “**spectrum of intelligence, learning, emotions and memory**”.

How could NEONs be used?

NEONs might be **the interface for technologies and services.**

- They will answer your queries at a bank, welcome you at a restaurant, or read out the breaking news on television at an unearthly hour.
- This form of virtual assistance would be more effective, for example, while teaching languages, as NEONs will be capable of understanding and sympathising.

How are NEONs different from Virtual Assistants?

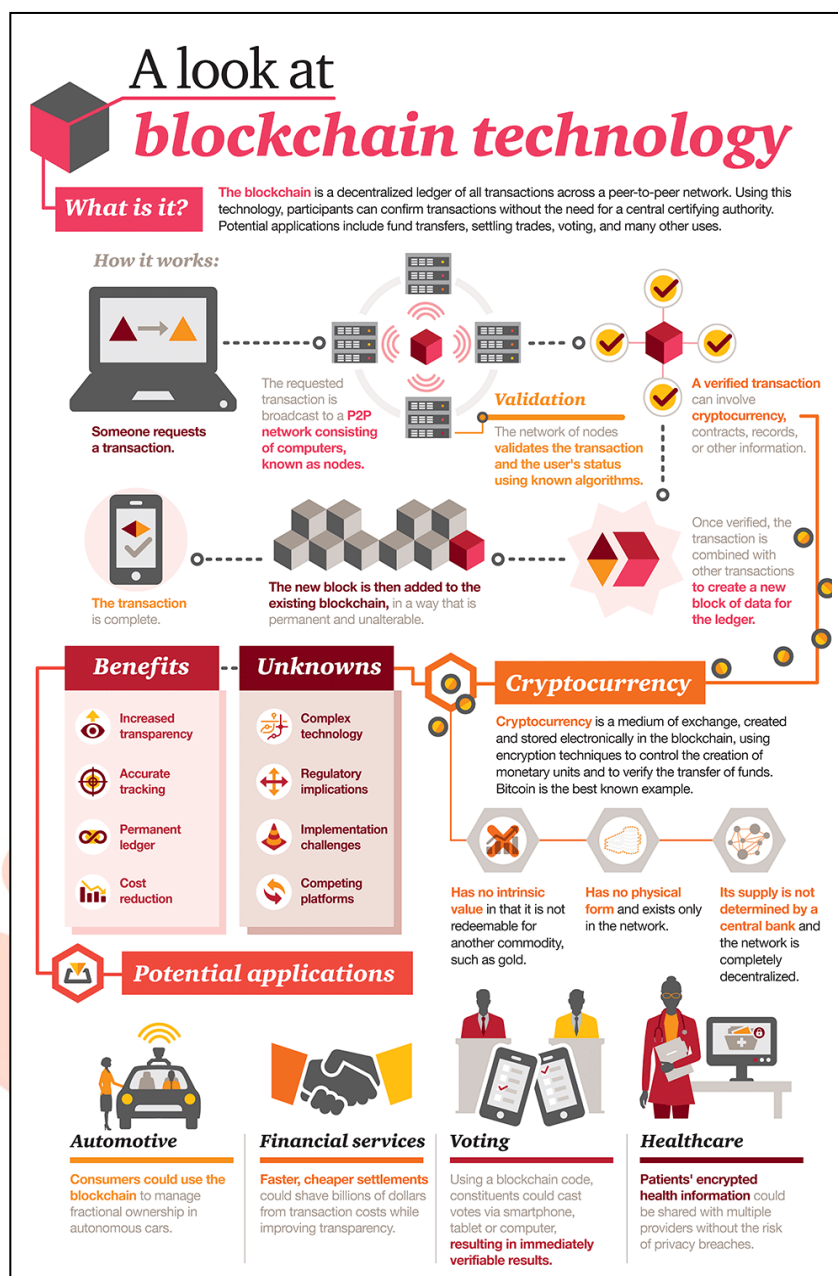
Virtual Assistants now learn from all the data they are plugged into. **NEONs will be limited to what they know and learn.** Their leaning could potentially be limited to the person they are catering to, and maybe her friends — but not the entire Internet. **They will not be an interface for you to request a song, rather they will be a friend to speak to and share experiences with, says Star Labs.**

12. Block Chain Technology

National Informatics Centre (NIC) has set up a Centre of Excellence (CoE) in **Blockchain Technology** in Bengaluru, which will provide Blockchain as a service and allow stakeholders to benefit from shared learning, experiences and resources.

Functions:

1. The Centre of Excellence will facilitate various government departments in building proof of concepts for use of Blockchain technology in different dimensions of governance, leading to large scale deployment of some such applications.
2. With National Informatics Centre (NIC) providing a robust and an agile infrastructure, the CoE shall also provide Blockchain as a Service (BaaS) for efficient hosting of Blockchain network, says an official release.



What are Blockchains?

Blockchains are a new data structure that is secure, cryptography-based, and distributed across a network.

- The technology supports cryptocurrencies such as Bitcoin, and the transfer of any data or digital asset.
- Spearheaded by Bitcoin, blockchains achieve consensus among distributed nodes, allowing the transfer of digital goods without the need for centralized authorisation of transactions.

How it operates?

1. The technology allows transactions to be simultaneously anonymous and secure, peer-to-peer, instant and frictionless.
2. It does this by distributing trust from powerful intermediaries to a large global network, which through mass collaboration, clever code and cryptography, enables a tamper-proof public ledger of every transaction that's ever happened on the network.
3. A block is the "current" part of a blockchain which records some or all of the recent transactions, and once completed, goes into the blockchain as permanent database.

- Each time a block gets completed; a new block is generated. Blocks are linked to each other (like a chain) in proper linear, chronological order with every block containing a hash of the previous block.

Benefits of blockchain technology:

- As a public ledger system, **blockchain records and validate each and every transaction made, which makes it secure and reliable.**
- All the transactions made are authorized by miners, which makes the **transactions immutable and prevent it from the threat of hacking.**
- Blockchain technology **discards the need of any third-party or central authority for peer-to-peer transactions.**
- It allows **decentralization of the technology.**

13. Extraocular Vision

The ability to see without eyes is known as extraocular vision. Previous researchers have defined it as the ability to resolve scenes without discrete eyes.

Researchers have shown that **red brittle star**, which are relatives of **starfish**, can see even though it does not have eyes. The red brittle star (*Ophiocoma wendtii*), which lives in the coral reefs of the Caribbean Sea, becomes **only the second creature, after a sea urchin species, known to have this ability (barring freak cases in other species).**

How it works?

In sea urchins and brittle stars, researchers suspect that extraocular vision is facilitated by the photoreceptor cells found on their bodies.

14. Head on Generation (HOG) technology

Between April 2018 and November 2019 around 436 trains have been converted into **HOG compliant.**

What is Head on Generation (HOG) technology?

The system runs the train's '**hotel load**' (the load of air conditioning, lights, fans, and pantry, etc.) by drawing electricity from the overhead electric lines through the **pantograph.**

The power supply from the overhead cable is **750 volts at single-phase, and a transformer with a winding of 945 kVA converts it to a 750 Volts 50 Hz output at 3-phase.** This energy is then provided to the compartments.

How is it different from the present EOG technology?

In **the End on Generation (EOG) system**, the 'hotel load' is provided with **electricity from two large diesel generator sets.**

The **generator cars are attached to either end of the train, giving the system its name.**

Benefits of HOG over EOG:

- HOG-fitted trains do not require power from diesel generators** and need only **one emergency generator car attached**, instead of two regular generator cars.
- HOG system is free of air and noise pollution:** It would bring down yearly CO₂ and NO_x emissions, which are currently at 1724.6 tonnes/annum and 7.48 tonnes/annum respectively, to zero.
- The reduction in emissions could also help the Railways accrue **carbon credits**, and trade them on the international market.
- With the noise-emitting generator sets gone, **noise pollution would also drop.**

15. Neutrino project

The Government of India had approved a project to build the **India-based Neutrino Observatory (INO)** at Pottipuram in the Theni District of Tamil Nadu.

About the project:

The India-based Neutrino Observatory (INO) Project is a multi-institutional effort aimed at building **a world-class underground laboratory** with a rock cover of approx. 1200 m **for non-accelerator based high energy and nuclear physics research in India**. The initial goal of INO is **to study neutrinos**.

It is a mega-science project **jointly funded by the Department of Atomic Energy (DAE) and the Department of Science and Technology (DST)**.

The project includes:

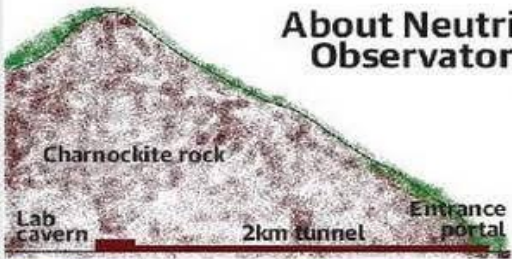
- Construction of an underground laboratory and associated surface facilities at **Pottipuram in Bodi West hills of Theni District of Tamil Nadu**.
- Construction of an **Iron Calorimeter (ICAL) detector for studying neutrinos**.
- Setting up of **National Centre for High Energy Physics at Madurai**, for the operation and maintenance of the underground laboratory, human resource development and detector R&D along with its applications.

What are neutrinos?

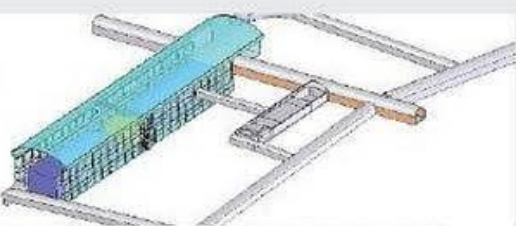
Neutrinos, first proposed by Swiss scientist Wolfgang Pauli in 1930, are **the second most widely occurring particle in the universe**, only second to photons, the particle which makes up light. In fact, neutrinos are so abundant among us that every second, there are more than 100 trillion of them passing right through each of us — we never even notice them.

Neutrinos occur in three different types, or flavours. These are separated in terms of different masses. From experiments so far, we know that neutrinos have a tiny mass, but the ordering of the neutrino mass states is not known and is one of the key questions that remain unanswered till

About Neutrino Observatory



Charnockite rock
Lab cavern 2km tunnel Entrance portal



A SCHEMATIC VIEW OF THE PROPOSED INDIA-BASED NEUTRINO OBSERVATORY UNDERGROUND LAB

| | | | |
|---|---|---|--|
| <p>Where</p> <p>At Pottipuram village in Theni district, on the Tamil Nadu-Kerala border</p> | <p>Why</p> <p>The initial goal of India-based Neutrino Observatory (INO) is to study neutrinos</p> | <p>Neutrino</p> <p>Neutrinos are the smallest particles that form the universe</p> | <p>Highlights</p> <p>Two underground laboratory caverns with a rock cover of over 1000 metres; access tunnel of 2 km length</p> |
|---|---|---|--|

Where else

| | |
|---|--|
| Underground SNO, Canada; Kamioka, Japan; Gran Sasso, Italy | Underwater Amundsen - Scott South Pole Station, Antarctica; Antares - under Mediterranean sea off the coast of Toulon, France |
|---|--|

today. This is a major challenge INO will set to resolve, thus completing our picture of the neutrino.

Why detect them?

Neutrinos hold the key to several important and fundamental questions on the origin of the Universe and the energy production in stars. Another important possible application of neutrinos is in the area of neutrino tomograph of the earth, that is detailed investigation of the structure of

the Earth from core onwards. This is possible with neutrinos since they are the only particles which can probe the deep interiors of the Earth.

Why should the laboratory be situated underground?

Neutrinos are notoriously difficult to detect in a laboratory because of their extremely weak interaction with matter.

- The background from cosmic rays (which interact much more readily than neutrinos) and natural radioactivity will make it almost impossible to detect them on the surface of the Earth. This is the reason most neutrino observatories are located deep inside the Earth's surface.
- The overburden provided by the Earth matter is transparent to neutrinos whereas most background from cosmic rays is substantially reduced depending on the depth at which the detector is located.

16. Fuel cell electric vehicles (FCEV)

Supreme Court had directed the government to look into the feasibility of introducing **vehicles based on a hydrogen cell technology** to deal with air pollution in the National Capital Region.

How does the hydrogen fuel cell work in electric vehicles?

A fuel-cell electric vehicle is essentially **a hybrid electric vehicle wherein, the internal combustion engine is replaced with a fuel-cell stack**. The onboard sources of power include hydrogen as well as an advanced battery system.

The fuel cell **combines hydrogen and oxygen to generate an electric current, water being the only byproduct**.

Fuel cells **generate electricity through an electrochemical process**.

And, **there are no moving parts in the fuel cell**, so they are more efficient and reliable by comparison.

How is it different from an electric vehicle (EV)?

Unlike a battery-electricity vehicle, **it does not store energy and, instead, relies on a constant supply of fuel and oxygen** — in the same way that an internal combustion engine relies on a constant supply of petrol or diesel, and oxygen.



Advantages of fuel cells:

- They produce **much smaller quantities of greenhouse gases and none of the air pollutants that cause health problems**.
- If pure hydrogen is used, fuel cells emit **only heat and water as a byproduct**.

- They are also **energy efficient** than traditional combustion technologies.
- Unlike battery-powered electric vehicles, **fuel cell vehicles do not need to be plugged in**, and most models exceed 300 km of range on a full tank. They are filled up with a nozzle, just like in a petrol or diesel station.

Disadvantages:

- The process of **making hydrogen needs energy** — often from fossil fuel sources. That has raised questions over hydrogen's green credentials.
- There are **questions of safety** — **hydrogen is more explosive than petrol**.
- Besides, the vehicles are expensive, and fuel dispensing pumps are scarce.

17. Biosimilar medicine

WHO prequalifies **first biosimilar medicine- trastuzumab-** to increase worldwide access to life-saving breast cancer treatment.

- **Trastuzumab – a monoclonal antibody** – was included in **the WHO Essential Medicines List** in 2015 as an essential treatment for about 20% of breast cancers.

What are Biosimilars?

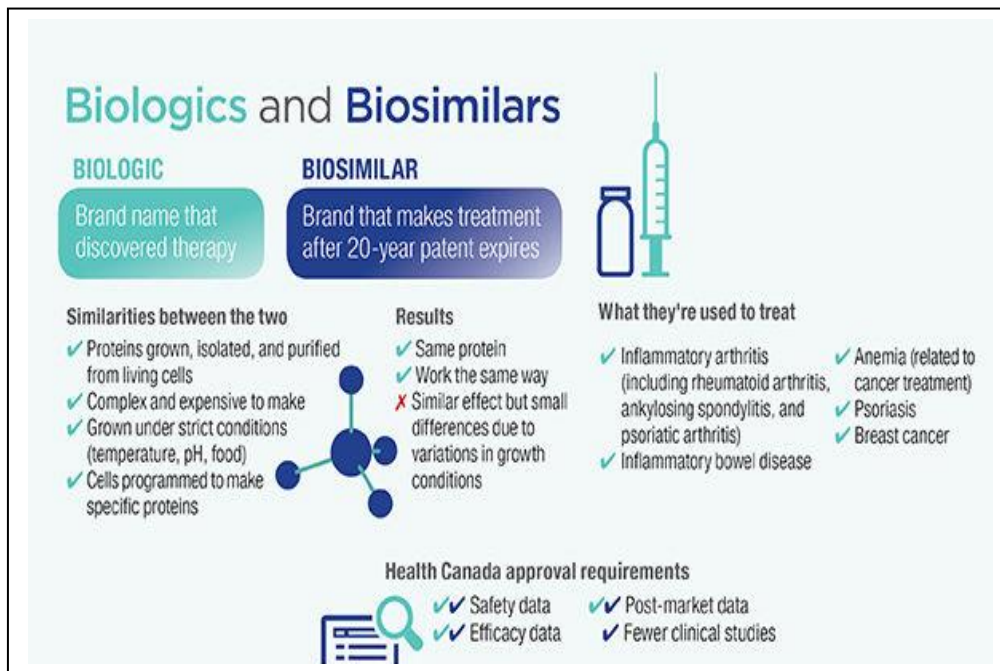
- It is **a biologic medical product** that is almost **an identical copy of an original product that is manufactured by a different company**.
- They are **officially approved versions of original “innovator” products and can be manufactured when the original product's patent expires**.
- **Reference to the innovator product** is an integral component of the approval.

Characteristics:

- Biological medicines **contain active substances from a biological source**, such as living cells or organisms.
- Most biological medicines in current clinical use **contain active substances made of proteins**.

Difference between biosimilars and generics:

- Biosimilars involve developing equivalent of **biological entity** while generics involve developing equivalent of a **chemical entity**-the Active Pharmaceutical Ingredient.
- **Cost:** Generic drugs are chemically identical to the original branded drug and, as such, cost significantly less because they don't require much testing. Because biosimilars are made from living organisms, though, and don't contain identical ingredients to their name-brand counterparts, they still require some testing. So, they cost more than generics, but less than the branded biologic.



18. FrogPhone

It is **the world's first solar-powered remote survey device** that can be installed at any frog pond and which receives a 3G or 4G cellular network.

Developed by **a team from various Australian institutions.**

- The FrogPhone will allow researchers to dial these devices remotely, and analyse the data later.
- It will reduce costs and risks, including the negative impact of human presence on the field site.
- These devices also allow for monitoring of local frog populations more frequently than before, which is important because these populations are recognised as indicators of environmental health.

19. Wi-Fi Calling

Bharti Airtel has introduced **Voice over Wi-Fi (VoWiFi), a first for India.**

- Wi-Fi Calling is aimed especially for areas where cellular networks are not strong.
- It uses high speed Internet connection, available via broadband, to make and receive high definition (HD) voice calls.
- Users don't have to pay extra for these calls as it is using a Wi-Fi network.
- Wi-Fi Calling can be configured on compatible smartphones by upgrading operating systems to the version that supports Wi-Fi Calling, and enabling this in Settings.

20. Microdots

Govt notifies rules for fixation of **microdots identifiers on vehicles.**

- Microdot technology involves **spraying the body and parts of the vehicle or any other machine with microscopic dots**, which give a unique identification.
- These microdots **can be read physically with a microscope and identified with ultra violet light source.**
- The microdots and adhesive will become **permanent fixtures/affixation which cannot be removed without damaging the asset, that is the vehicle itself.**
- **Benefits:** Use of this technology will help check theft of vehicles and also use of fake spare parts.

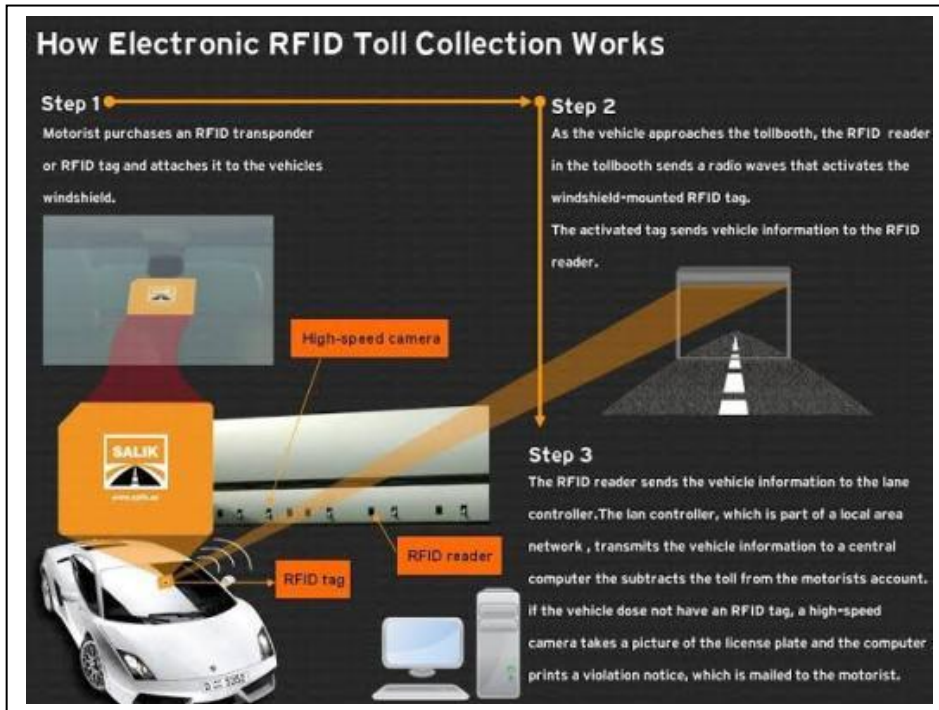
21. FASTag

How does FASTag work?

The device employs **Radio Frequency Identification (RFID) technology** for payments directly from the prepaid or savings account linked to it.

It is **affixed on the windscreen of the vehicle**.

It is **valid for five years, and can be recharged as and when required**.



The payment method is a part of **the National Electronic Toll Collection (NETC) programme**. **The National Payments Corporation of India (NPCI)** collects the payments.

The **“One Nation One FASTag”** scheme aims to integrate the collection of toll digitally and ensure seamless mobility of vehicles across India.

22. Secretagoin

Scientists have recently demonstrated the role of a protein **secretagoin (SCGN)** in **increasing insulin action in obesity-induced diabetes**.

- SCGN is now established as **a functional insulin-binding protein** with therapeutic potential against diabetes.
- SCGN binds to insulin and protects it from various stresses, increases its stability and adds to its action.
- SCGN is **found in lower quantities in the brains of Alzheimer's patients**.

23. Microbial Fuel Cells

Microbial fuel cells have been installed at a zoo in London.

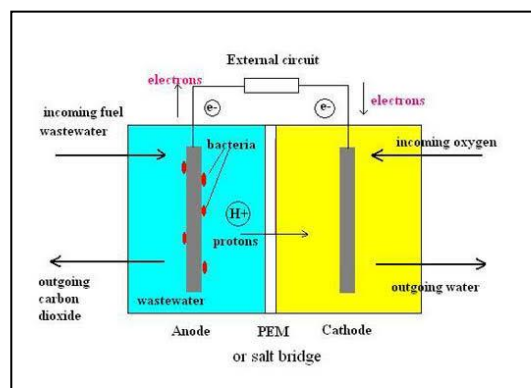
Using these cells, a plant has taken **the botanical world's first selfie**.

What are microbial fuel cells?

A device that converts chemical energy to electrical energy by the action of microorganisms.

How it works?

- Under sunlight, plants produce sugars and oxygen from water and CO₂ (photosynthesis).
- These sugars do not remain in the leaves, but are transported throughout the plant to the stem and roots.
- Some of these sugars are excreted by the roots as a waste product from the plant.
- Soil micro-organisms break this down further, releasing energy.



- This energy is captured using an anode (minus) and a cathode (plus) and charge a super capacitor.
- When the super capacitor is full, the power is discharged and a photo is taken.

Significance:

Unlike solar panels, plants can survive in the shade, naturally moving into position to maximise the potential of absorbing sunlight.

24. Project Soli

Recently launched Google Pixel 4 uses **a radar-based Soli chip** to introduce Motion Sense, a feature that provides similar touchless gesture-based controls.

What is Project Soli?

Google announced Project Soli in 2015. Since then, Google's **ATAP (Advanced Technology and Projects)** division has been developing the technology, which can be used in wearables, phones, computers, cars and IoT devices.

What is Google's Soli chip?

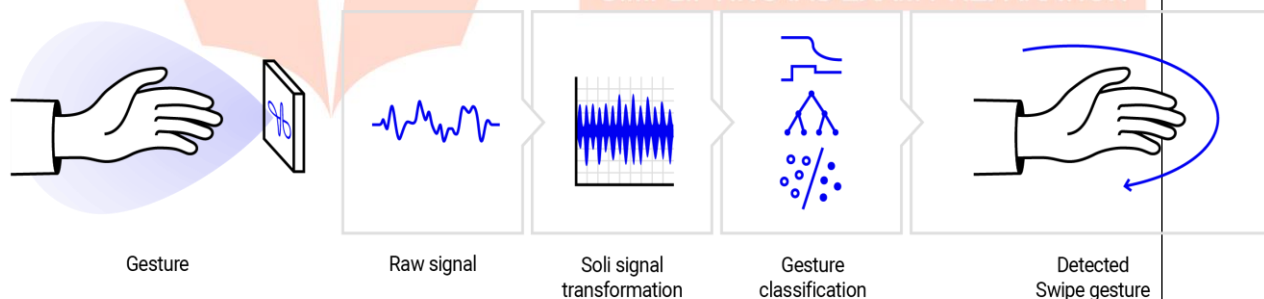
Google's Soli is **a purpose-built chip** to track your motion on a microscopic scale.

It **uses miniature radar** for real-time motion tracking of the human hand; it's able to track sub-millimetre motion at high speeds with great accuracy.

How does Google's Soli chip work?

The Google Soli chip uses radar, so it works by emitting electromagnetic waves with objects within the beam reflecting information back to the antenna.

Information gathered from the reflected signal - things like time delay or frequency changes - give the device information about the interaction.

**Why does India not allow the Soli chip?**

The Soli radar chip works on the 60 GHz spectrum frequency as it has the least interference for the kind of minute movements Google wants to track. However, the **60 GHz spectrum is not commercially usable in India.**

The 60 GHz band is also known as **V-band or WiGig band (Wi-Fi at 60 GHz)** using IEEE 802.11ad protocol.

25. Nanopharmaceuticals

Guidelines Released for Evaluation of **Nanopharmaceuticals** in India.

Guidelines are developed by DBT, ICMR and Central Drugs Standard Control Organization (CDSCO).

Developed **in line with the provisions of Schedule Y of Drugs and Cosmetics Rules, 1945 as well as Second Schedule of the New Drugs and Clinical Trials Rules, 2019** with specific requirements for nanopharmaceuticals.

What are Nanopharmaceuticals?

They are a relatively new class of **therapeutic-containing nanomaterials** that often have unique "nanoproperties" (physiochemical properties) due to their small size (compared with their bulk-phase counterparts) a high surface-to-volume ratio and the possibility of modulating their properties.

- **Nanopharmaceuticals present novel reformulation opportunities for active agents** (e.g., single molecule drugs, proteins, nucleic acids, etc.) that were previously insoluble or could not be targeted to a specific site of the body where they were needed.
- Nanopharmaceuticals can **also increase drug half-life** by reducing immunogenicity and diminishing drug metabolism.
- With these advantages, **nanopharmaceuticals have the ability to extend the economic life of proprietary drugs**, thereby creating additional revenue streams.

26. Edge Computing

According to a research, by 2025, companies will generate and process more than 75% of their data outside of traditional centralised data centres — that is, **at the “edge” of the cloud**.

What is edge computing?

Edge computing **enables data to be analysed, processed, and transferred at the edge of a network**. Meaning, **the data is analysed locally**, closer to where it is stored, in real-time without latency, rather than send it far away to a centralised data centre.

It **allows for quicker data processing and content delivery**.

How is edge computing different from cloud computing?

The basic difference between edge computing and cloud computing lies **in where the data processing takes place**.

Internet of Things (IoT) systems perform all of their computations **in the cloud using data centres**.

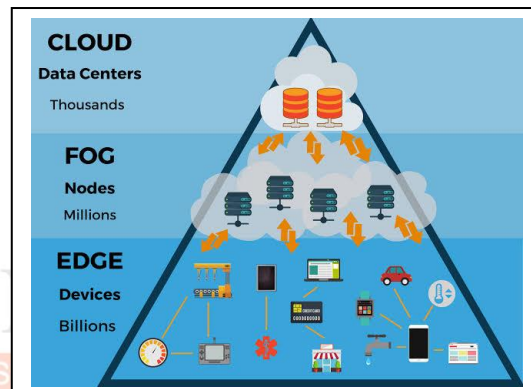
In **Edge computing**, massive amounts of data generated by IoT devices are stored and processed locally. **That data doesn't need to be sent over a network as soon as it processed; only important data is sent** — therefore, an edge computing network reduces the amount of data that travels over the network.

Benefits:

Edge computing may **offer some protection against a catastrophic attack where a single incident can compromise large amounts of a company's data**.

In some ways, **it's more resilient, because instead of one or two or even three data centers**, you have distributed data and compute on the edge, which makes it much more resilient to malicious and nonmalicious events.

It offers high speed, reduced latency & better reliability which allows for quicker data processing and content delivery.



27. Gagan Enabled Mariner's Instrument for Navigation and Information (GEMINI) Device

- It is a device that used for seamless and effective dissemination of emergency information and communication on disaster warnings, Potential Fishing Zones (PFZ) and Ocean States Forecasts (OSF) to fishermen.
- The device will help to provide information related to disaster warnings when fishermen move away from the coast beyond 10 to 12 kilometres.
- The GEMINI device receives and transfers the data received from GAGAN satellite/s to a mobile through Bluetooth communication. A mobile application developed by INCOIS decodes and displays the information in nine regional languages.
- It has been **developed by Indian National Centre for Ocean Information Services (INCOIS), and Airports Authority of India (AAI).**

28. Elastocaloric Effect

It is **a cooling effect produced when rubber bands are twisted and untwisted.**

How it works? In the elastocaloric effect, the transfer of heat works much the same way as when fluid refrigerants are compressed and expanded. When a rubber band is stretched, it absorbs heat from its environment, and when it is released, it gradually cools down.

Applications: The elastocaloric effect, if harnessed, may be able to do away with the need of fluid refrigerants used in fridges and air-conditioners. These fluids are susceptible to leakages, and can contribute to global warming.

29. High-Temperature Proton Exchange Membrane (HTPEM) technology

- **India's first indigenously developed high-temperature based Fuel Cell System** was recently introduced. It is a 5.0 kW fuel cell system that generates power in a green manner.
- The developed fuel cells are based on **High-Temperature Proton Exchange Membrane (HTPEM) technology.**

Key facts:

- Developed under the Public-Private Partnership (PPP) model **by the Council of Scientific and Industrial Research (CSIR)** in partnership with Indian industries.
- Built under India's flagship programme named '**New Millennium Indian Technology Leadership Initiative (NMITLI)**'.

How it works?

- It takes methanol or bio-methane as the input and produces heat and water as its bi-products, which can be further used. This helps to attain an efficiency that is greater than 70%, which is difficult to achieve by other energy sources.

What is HTPEM technology?

- High Temperature Proton-Exchange-Membrane (HTPEM) is the core of the fuel cells running above 150 °C. As in classical PEM fuel cells technology, Hydrogen is electrochemically split to proton and electron on anode. Proton is transported through membrane to cathode while electricity is yielded in external circuit. At cathode protons recombine with electron and reacts further with Oxygen to water and heat.
- The technology can achieve efficiency approaching 90% calculated as combined yield of electricity and heat.

Applications:

- Suitable for distributed stationary power applications like; for small offices, commercial units, data centers etc.; where highly reliable power is essential with simultaneous requirement for air-conditioning.
- It will also meet the requirement of efficient, clean and reliable backup power generator for telecom towers, remote locations and strategic applications as well.
- Replace Diesel Generating (DG) sets and help reduce India's dependence on crude oil.

- HT-PEM Technology enables simple and cost-effective fuel cell systems that can operate on fuel sources available today, such as natural gas, propane, and methanol.

What is New Millennium Indian Technology Leadership Initiative (NMITLI)?

- It is the **largest Public-Private-Partnership effort within the R&D domain in the country.**
- It seeks to **catalyze innovation centred scientific and technological developments as a vehicle to attain for Indian industry a global leadership position, in selected niche areas.**
- It **synergizes the best competencies of publicly funded R&D institutions, academia, and private industry.**
- It has so far evolved 60 largely networked projects in diversified areas viz. Agriculture & Plant Biotechnology, General Biotechnology, Bioinformatics, Drugs & Pharmaceuticals, Chemicals, Materials, Information and Communication Technology, and Energy.

30.C-DOT'S LATEST INNOVATIONS

- **Centre for Development of Telematics (C- DOT)** has launched its latest innovations, **“C-Sat-Fi (C-DOT Satellite WiFi)”, “XGSPON (10 G Symmetrical Passive Optical Network)” and “C-DOT’s Interoperable Set-Top Box (CiSTB).**
- **C-Sat-Fi (C-DOT Satellite WiFi):** It is based on the optimal utilization of wireless and satellite communication to extend connectivity to the unserved areas including the remote islands and difficult terrains. Besides offering the ease of deployment, the solution is ideally suited to addressing disasters and emergencies when no other means of communication are available. **This cost-effective solution does not require expensive Satellite Phones and can work on any WiFi-enabled phone.**
- **C-DOT’s XGSPON (10 G Symmetrical Passive Optical Network):** It will help in meeting the demands of applications like IPTV, HD Video Streaming, Online Gaming and host of other cloud-based services that necessitate the seamless availability of high bandwidth.
- **C-DOT’s Interoperable Set-Top Box (CiSTB):** This solution will revolutionize the experience of the Cable TV operators by offering them a high degree of choice, ease and convenience without having to replace the once installed STB.

Government Initiatives / Departments

1. Ease 3.0 for tech-enabled banking

FM Nirmala Sitharaman launched **Ease 3.0 for tech-enabled banking**.

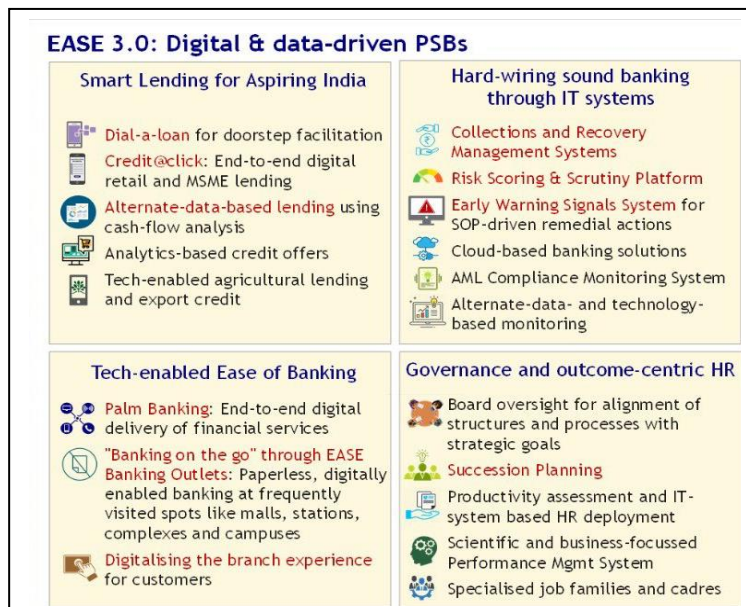
This move is expected to **change the customer's experience at the Public Sector Banks (PSBs)**.

What is it?

Ease (Enhanced Access and Service Excellence) 3.0 reform agenda aims at providing smart, tech-enabled public sector banking for aspiring India.

New features that customers of public sector banks may experience under EASE 3.0 reforms agenda include facilities like:

- **Palm Banking** for "End-to-end digital delivery of financial service".
- **"Banking on Go"** via EASE banking outlets at frequently visited spots like malls, stations, complexes, and campuses.



The idea behind EASE 3.0 agenda:

- The Ministry has the idea of establishing paperless and digitally-enabled banking at places where people visit the most.
- The government aims to focus on digitalization in the Public Sector Banks (PSBs) among themes that include responsible banking, PSBs as Udyami Mitra, customer responsiveness, credit take-off, and deep financial inclusions.

Background:

- **PSB Reforms EASE Agenda** is a common reform agenda for PSBs aimed at institutionalizing clean and smart banking.
- It was **launched in January 2018**, and the subsequent edition of the program — EASE 2.0 built on the foundation laid in EASE 1.0 and furthered the progress on reforms.
- In EASE 2.0, the government had proposed pushing liquidity in the public sector banks, reconstituting the management committee and possible mergers among the ideal partners in the Indian banking sector.

2. Sophisticated Analytical & Technical Help Institutes (SATHI)

The Department of Science & Technology has launched a unique scheme called **"Sophisticated Analytical & Technical Help Institutes (SATHI)"**.

About the scheme:

Aim: To address the need for **building shared, professionally managed and strong S&T infrastructure** in the country which is readily accessible to academia, start-ups, manufacturing, industry and R&D labs etc.

Implementation:

- These Centres are expected to **house major analytical instruments** to provide common services of high-end analytical testing, thus avoiding duplication and reduced dependency on foreign sources.
- These would be operated with a transparent, open access policy.
- DST has already set up three such centres in the country, one each at IIT Kharagpur, IIT Delhi and BHU.

Objectives of the Scheme:

- To address the problems of accessibility, maintenance, redundancy and duplication of expensive equipment in the institutions.
- This will also foster a strong culture of collaboration between institutions and across disciplines to take advantage of developments, innovations and expertise in diverse areas.

3. National Technical Textiles Mission

The **Cabinet Committee on Economic Affairs (CCEA)** had approved the setting up of a **National Technical Textiles Mission**.

Aim: To position the country as a global leader in technical textiles and increase the use of technical textiles in the domestic market.

Key facts:

The Mission will be implemented for four years from 2020-2021 and will have **four components**:

- The first component will **focus on research and development and innovation**. The research will be at both, fibre level and application-based in geo, agro, medical, sports and mobile textiles and development of bio-degradable technical textiles.
- The second component will be for **promotion and development of market for technical textiles**. The Mission will aim at taking domestic market size to \$40 billion to \$50 billion by 2024.
- The third component will focus on **export promotion** so that technical textile exports from the country reach from the ₹14,000 crore now to ₹20,000 crore by 2021-2022 and ensure 10% average growth every year till the Mission ends.
- The last component will be on **education, training and skill development**.

What are technical textiles?

Technical textiles are defined as textile materials and products manufactured primarily for their technical performance and functional properties rather than **aesthetic and decorative characteristics**.

Technical textiles include textiles for automotive applications, medical textiles (e.g., implants), geotextiles (reinforcement of embankments), agrotextiles (textiles for crop protection), and protective clothing (e.g., heat and radiation protection for fire fighter clothing, molten metal protection for welders, stab protection and bulletproof vests, and spacesuits).

Significance and potential applications:

- Technical Textiles are being used globally for last several decades. These materials have provided **innovative engineering solutions** for several applications in **civil and geotechnical engineering, for infrastructure water resources projects**.

| What are Technical Textiles? | |
|--|--|
| Conventional Textiles | Technical Textiles |
| <ul style="list-style-type: none"> • Manufactured primarily for aesthetic or decorative purpose • Fiber (natural or synthetic) is usually first Spun into Yarn and then Yarn is Woven / Knit into Fabric | <ul style="list-style-type: none"> • Manufactured primarily for performance or function rather than aesthetics • May be both woven and non woven, and is made out of primarily synthetic and some natural fibers |

- Even while Technical Textiles have been extensively used in developed as well as many developing countries, India has yet to capitalise the technical, economical and environmental benefits on large scale.
- Various parts of India are subjected to floods and environmental degradation. In some of the terrains, the **flood management and control** can rely on Technical Textiles tubes, containers and bags. Technical Textiles have been found to **perform better than concrete** as water protection component because of permeability, flexibility and ease of underwater placement.

4. CSIR-IICT Nuclear Magnetic Resonance test facility

The **CSIR-Indian Institute of Chemical Technology (CSIR-IICT)**, Hyderabad has announced that **the Nuclear Magnetic Resonance (NMR) test facility** at the institute has passed the US Food and Drug Administration (USFDA) inspection with “no observations”.

What is NMR?

The NMR spectroscopy is **an important technique for structural characterization of pharmaceutical and other chemical molecules.**

The technique is **used in quality control and reserach for determining the content and purity of a sample as well as its molecular structure.**

5. Government Instant Messaging System (GIMS)

Designed and developed by **National Informatics Centre (NIC)**.

It is being packaged **for employees of Central and state government departments and organisations for intra and inter organisation communications.**

It is **an Indian equivalent of popular messaging platforms**, such as WhatsApp and Telegram, for secure internal use.

It is being developed as **a secure Indian alternative without the security concerns attached with apps hosted abroad or those owned by foreign entities.**

Like WhatsApp, GIMS employs **end-to-end encryption for one-to-one messaging.**

6. EChO Network

Indian Government has launched a network to encourage cross-disciplinary leadership- Called **EChO Network.**

Aim: To identify gaps in knowledge regarding environment and then train postdoctoral leaders in research and outreach on these topics, incorporating current public and private efforts.

Key features:

- It will provide a template for cross-disciplinary leadership in India with the specific focus of increasing research, knowledge, and awareness of Indian ecology and the environment.
- The Network would develop a national network to catalyse a new generation of Indians who can synthesize interdisciplinary concepts and tackle real-world problems in medicine, agriculture, ecology, and technology.

How it works?

- Through interactive sessions with citizens, industry, academia, and the government, the Network will identify gaps in knowledge regarding selected topics in human and environmental ecosystems.
- The program will then train postdoctoral leaders in research and outreach on these topics, while also incorporating current public and private efforts into a national network.
- It would then go on to establishing nation-wide awareness in these issues through public discourse and education for citizens, industry, and government with information exchange at all educational levels.

7. RailWire Wi-Fi

The Railways has successfully completed the work of providing free public Wi-Fi at 5500 stations across the country.

What is RailWire?

RailWire is **a retail Broadband initiative of the RailTel.**

- It envisages extending broadband and application services to the public.
 - The Wi-Fi at stations has been provided in association with **Google as the technology partner.**
- RailTel Corporation** is a “Mini Ratna(Category-I)” PSU of Ministry of Railways. It is the largest neutral telecom services providers in the country.

8. Trakea

It is **a unique barcoding software adopted by Haryana Police.** Haryana Police claims **it is the country's first police force to have introduced this unique barcoding for forensic reports.**

Objective: To ensure that thousands of forensic reports that form the backbone of the criminal investigation system and subsequent trials in the courts of law, are not tampered with.

Significance: Trakea ensures foolproof security of the samples collected from the scene of crime, and the forensic analysis reports.

9. Patent Prosecution Highway (PPH) programme

The Government had approved the proposal for adoption of **Patent Prosecution Highway (PPH) programme by the Indian Patent Office (IPO)** under **the Controller General of Patents, Designs & Trade Marks, India (CGPDTM)** with patent offices of various other interest countries or regions.

Eligibility:

Under this Pilot programme, Indian Patent Office may receive patent applications in certain specified technical fields only, namely, Electrical, Electronics, Computer Science, Information Technology, Physics, Civil, Mechanical, Textiles, Automobiles and Metallurgy while JPO may receive applications in all fields of technology.

What is PPH?

The Patent Prosecution Highway (PPH) is **a set of initiatives for providing accelerated patent prosecution procedures by sharing information between some patent offices.**

How it works?

This would allow a patent applicant to demand fast-tracking of his patent application by showing that his product or process has already been granted a patent in Japan.

PPH programme would lead to the following benefits for the Indian IP office:

- Reduction in time to dispose patent applications.
- Reduction in pendency of patent applications.
- Improvement in quality of search and examination of patent applications.
- An opportunity for Indian inventors including MSMEs and Startups of India to get accelerated examination of their patent applications in Japan.

A **Bilateral Patent Prosecution Highway (PPH) pilot program has commenced between the Indian Patent Office (IPO) and the Japan Patent Office (JPO).**

10. India's First e-waste Clinic

- India's first e-waste clinic for segregating, processing and disposal of waste from household and commercial units will be **set-up in Bhopal, Madhya Pradesh.**
- The clinic is being conceived in compliance with **the Solid Waste Management Rules, 2016.**

- The e-waste clinic would enable segregation, processing and disposal of waste from both household and commercial units.

11. LOTUS-HR Project

The launch of the second phase of the **Local Treatment of Urban Sewage streams for Healthy Reuse (LOTUS-HR) program** was recently held. It is located in Delhi.

- The LOTUS-HR project is jointly supported by Department of Biotechnology, Ministry of Science and Technology, Government of India and Netherlands Organization for Scientific Research.
- The project was initiated in July 2017 and aims to demonstrate a novel holistic (waste) water management approaches that will produce clean water which can be reused for various purposes.

12. Deep Ocean Mission

- **Deep Ocean mission** is the Government of India mission to study the various aspects of ocean in an integrated frame work as the Indian Space Research Organisation (ISRO) has been studying the space.

Features of the Mission:

- The **focus of the mission** will be on deep-sea mining, ocean climate change advisory services, underwater vehicles and underwater robotics related technologies.
- **Two key projects** planned in the 'Deep Ocean Mission' report include **a desalination plant** powered by tidal energy and **a submersible vehicle** that can explore depths of at least 6,000 metres.
- The 'Deep Ocean Mission' plan will enable India to develop capabilities **to exploit resources in the Central Indian Ocean Basin (CIOB)**.

What will be mined from the deep ocean?

- One of the main aims of the mission is to explore and extract **polymetallic nodules**. These are small potato- like rounded accretions **composed of minerals such as manganese, nickel, cobalt, copper and iron hydroxide**.
- They **lie scattered on the Indian Ocean floor at depths of about 6,000 m** and the size can vary from a few millimetres to centimetres. These metals can be extracted and used in electronic devices, smartphones, batteries and even for solar panels.

How is it regulated?

- The **International Seabed Authority (ISA)**, an autonomous international organisation established under the
- 1982 United Nations Convention on the Law of the Sea, allots the 'area' for deep-sea mining.
- India was the first country to receive the status of a 'Pioneer Investor ' in 1987 and was given an area of about 1.5 lakh sq km in the **Central Indian Ocean Basin (CIOB)** for nodule exploration. In 2002, India signed a contract with the ISA and after complete resource analysis of the seabed 50% was surrendered and the country retained an area of 75,000 sq km.
- Which are the other countries that are in the race to mine the deep sea?
- Apart from the CIOB, polymetallic nodules have been identified from the central Pacific Ocean. It is known as the **Clarion-Clipperton Zone**.
- China, France, Germany, Japan, South Korea, Russia and also some small islands such as the Cook Islands, Kiribati have joined the race for deep sea mining. Most of the countries have tested their technologies in shallow waters and are yet to start deep-sea extraction.

What will be the environmental impact?

- According to the International Union for Conservation of Nature (IUCN), these deep remote locations can be home to unique species that have adapted themselves to conditions such as poor oxygen and sunlight, high pressure and extremely low temperatures.
- Such mining expeditions can make them go extinct even before they are known to science. The deep sea's biodiversity and ecology remain poorly understood, making it difficult to assess the environmental impact and frame adequate guidelines.
- Environmentalists are also worried about the sediment plumes that will be generated as the suspended particles can rise to the surface harming the filter feeders in the upper ocean layers. Additional concerns have been raised about the noise and light pollution from the mining vehicles and oil spills from the operating vessels.

Is deep sea mining economically viable?

- The latest estimate from the ISA says it will be commercially viable only if about three million tonnes are mined per year.

13. Sagar Maitri Mission-2

- DRDO Research Ship **INS Sagardhwani** Embarks on Sagar Maitri Mission-2.
- SAGAR MAITRI is a unique initiative of DRDO which aligns with the broad objective of Prime Minister Narendra Modi's policy declaration "**Safety And Growth for All in the Region (SAGAR)**" to promote closer co-operation in socio-economic aspects as well as greater scientific interaction especially in ocean research among Indian Ocean Rim (IOR) countries.
- Under the aegis of PM's policy, specific scientific component of DRDO is "**MAITRI (Marine & Allied Interdisciplinary Training and Research Initiative)**".
- SAGAR MAITRI Mission-2 commemorates the Golden Jubilee Celebrations of India's lone research ship INS Kistna's missions as part of the historic International Indian Ocean Expeditions (IIOE), which took place during 1962-65.
- The prime objectives of the SAGAR MAITRI Mission are data collection from the entire North Indian Ocean, focussing on the the Andaman Sea and adjoining seas and establishing long-term collaboration with eight IOR countries in the field of ocean research and development.
- The programme also aims at establishing long term scientific collaboration with these countries in the field of 'Ocean Research & Development' and data collection with a focus in the Andaman Sea.

14. MANAV : Human Atlas Initiative

- **Department of Biotechnology (DBT)** has launched **MANAV: Human Atlas Initiative**, towards improving knowledge on human physiology.

What is MANAV: Human Atlas Initiative?

- It is a project funded by DBT.
- Aims at creating a **database network of all tissues in the human body** from the available scientific literature.
- It is a project that involves **scientific skill development for annotation, science outreach along with handling big data.**
- The programme will involve **gaining better biological insights through physiological and molecular mapping, develop disease models through predictive computing and have a wholistic analysis and finally drug discovery.**

Who can participate in this project?

- The project can be signed up by students who are in their final year graduation and above. Students from the fields of biochemistry, biotechnology, microbiology, botany, zoology, bioinformatics, health sciences, systems biologists, pharmacologists and data sciences can associate with this project.

- Even participants having a science background but not necessarily involved in active scientific research can be part of this network.

What are the applications of information generated through MANAV?

- The aim of the project remains to understand and capture the human physiology in two stages – in a normal stage and while in a disease stage. Such a database on individual tissues, once ready, can come handy in tracing the causes of a disease, understanding specific pathways and ultimately decode the body's disease stage linked to tissues and cells. The teams will also study any potent elements or molecules that have never been used in the form of drugs, to target the specific cells or tissues.



INSIGHTSIAS
SIMPLIFYING IAS EXAM PREPARATION

Biotechnology

1. IndiGen Genome project

The **Council of Scientific and Industrial Research (CSIR)** had announced the conclusion of a six-month exercise (from April 2019) of conducting a “whole-genome sequence” of a 1,008 Indians. The project is part of a programme called “IndiGen” and is also seen as a precursor to a much larger exercise involving other government departments to map a larger swathe of the population in the country.

IndiGen Genome project was *implemented by the CSIR-Institute of Genomics and Integrative Biology (IGIB), Delhi and CSIR-Centre for Cellular and Molecular Biology (CCMB), Hyderabad.*

Significance, outcomes and benefits of the project:

The outcomes of the IndiGen will have applications in a number of areas including **predictive and preventive medicine with faster and efficient diagnosis of rare genetic diseases.**

The data will be **important for building the knowhow, baseline data and indigenous capacity in the emerging area of Precision Medicine.**

About Genomics for Public Health in India (IndiGen) programme:

IndiGen programme aims **to undertake whole genome sequencing of thousands of individuals representing diverse ethnic groups from India.**

The objective is to enable genetic epidemiology and develop public health technologies applications using population genome data.

2. Genome India Project

The government has cleared an ambitious gene-mapping project, called **Genome India Project.**

Overview of Genome India Project:

The Genome India Project will **involve 20 leading institutions including the Indian Institute of Science (IISc) in Bengaluru and a few IITs.**

The first stage of the project will look at samples of “10,000 persons from all over the country” to form a “grid” that will enable the development of a “reference genome”.

The **IISc’s Centre for Brain Research**, an autonomous institute, will serve as the nodal point of the project.

Significance:

The project is said to be among **the most significant of its kind in the world because of its scale and the diversity it would bring to genetic studies.**

- The data generated would be accessible to researchers anywhere for analysis. As the genetic landscape differs across the world, it is necessary that **genetic data is shared in order to derive greater knowledge from information and serve the purpose of enabling better treatment outcomes.**
- The initiative will pave the way for **identifying genes and genetic variations for common diseases**, treating Mendelian disorders, enabling the transformation of the Precision Medicine landscape in India, and thus **improving the healthcare of the general population in our country.**

Need for genome sequencing:

Mapping the diversity of India’s genetic pool will lay the bedrock of **personalised medicine** and put it on the global map. Considering the diversity of population in our country, and the disease burden of complex disorders, including diabetes, mental health, etc., once we have a genetic basis, it may be **possible to take action before the onset of a disease.**

What is genome sequencing?

A **genome** is an organism's complete set of DNA, including all of its genes.

Genomics is an interdisciplinary field of science focusing on the structure, function, evolution, mapping, and editing of genomes.

Genomics also involves the sequencing and analysis of genomes through uses of high throughput DNA sequencing.

Advances in genomics have triggered a revolution in **discovery-based research** and systems biology to facilitate **understanding of even the most complex biological systems such as the brain**.

3. National Genomic Grid (NGG)

- The government had announced to set up a **National Genomic Grid (NGG)**.

About NGG:

- It will **study genomic data of cancer patients** from India.
- It will collect samples from cancer patients, through a network of pan- India collection centres by bringing all cancer treatment institutions on board.
- The grid to be formed will be in line with the **National Cancer Tissue Biobank (NCTB)** set up at the Indian Institute of Technology, Madras.

NCTB:

- **National Cancer Tissue Biobank (NCTB)**, is a joint initiative of the **Department of Science and Technology (DST), Government of India and Indian Institute of Technology, Madras**.
- It collects cancer tissue samples with consent from patients diagnosed with cancer.
- The aim is to provide researchers with high quality of cancer tissues and the patient data in order to facilitate cancer research that will lead to improvements in cancer diagnosis and treatment.
- This research is carried out through the technique of **Genome Sequencing**.

Significance:

- Through the National Genomic Grid, the government seeks to boost cancer research and make treatment viable for people of different economic classes.
- NGG will help to study genomic factors influencing cancer and identifying the right treatment modalities for the Indian population.

4. Antibiotic Resistance

Findings of the new study by researchers at the **Public Health Foundation of India (PHFI)** on Antibiotic prescription rates in India has been published.

Key findings:

- India is one of the top users of antibiotics.
- The private sector clocked high levels of antibiotic prescription rates (412 per 1,000 persons per year).
- The highest rate was seen among children aged 0–4 years (636 per 1,000 persons) and the lowest in the age group 10–19 years (280 per 1,000 persons).
- Per-capita antibiotic consumption in the retail sector has increased by around 22% in five years from 2012 to 2016.

What is it?

Antimicrobial resistance (AMR) is the ability of a microorganism (like bacteria, viruses, and some parasites) to stop an antimicrobial (such as antibiotics, antivirals and antimalarials) from working against it. As a result, standard treatments become ineffective, infections persist and may spread to others.

When an organism is **resistant to more than one drug, it is said to be multidrug-resistant.**

Why is Antibiotic Resistance a Big Deal? Although antibiotic resistance develops naturally with normal bacterial mutation, humans are speeding it up by using antibiotics improperly.

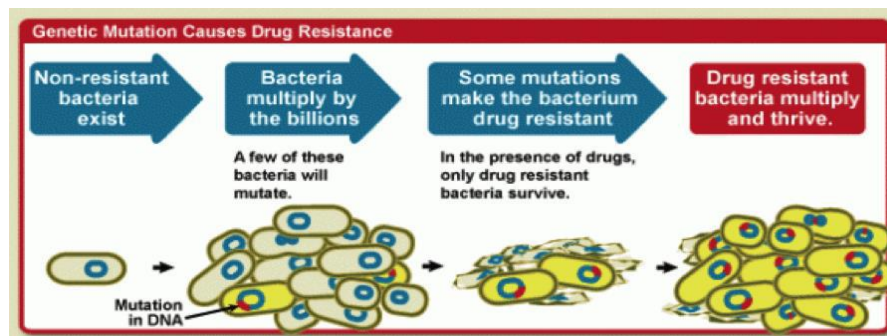
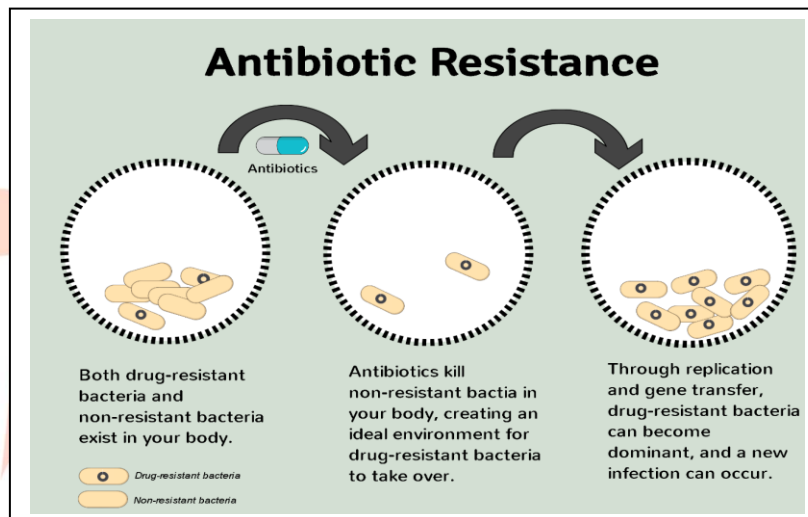
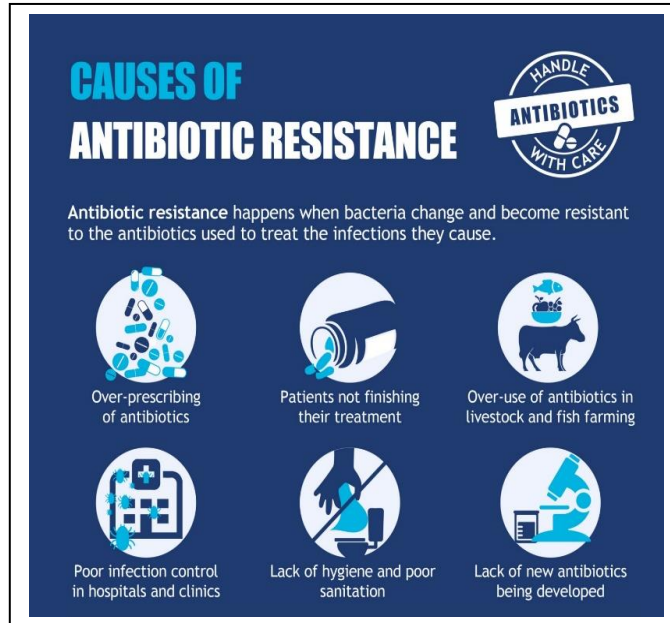
Why is the medical community worried?

- Basically, superbugs are becoming more powerful and widespread than ever. Medical experts are afraid that we're one step away from deadly, untreatable infections, since the **mcr-1 E.coli is resistant to that last-resort antibiotic Colistin.** Antibiotic-resistance is passed relatively easily from one bacteria to the next, since it is **transmitted by way of loose genetic material** that most bacteria have in common.
- **The World Health Organization (WHO)** is afraid of a post-antibiotic world, where loads of bacteria are superbugs. Already, infections like tuberculosis, gonorrhoea, and pneumonia are becoming harder to treat with typical antibiotics.
- Misuse of antibiotics in humans, animals, and aquaculture contributes to AMR. Also, poor management of waste from farms, factories, healthcare settings and households adds to the problem.

Other Related Information:

- To strengthen the surveillance of antimicrobial resistance (AMR) in the country, **Indian Council of Medical Research**

(ICMR) has set up a **National Anti-Microbial Resistance Research and Surveillance Network (AMRRSN)** to enable compilation of National Data of AMR at different levels of Health Care.



- India had released its **National Action Plan on AMR (NAP-AMR)** along with a **Declaration in Delhi** in 2017. The NAP-AMR calls for states to consider AMR as a state level priority and develop **state level action plans** to ensure on-the-ground implementation.
- **Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR)** has been released. With this, MP has become the second state in India after Kerala to develop an action plan to manage antimicrobial resistance (AMR). The MP-SAPCAR focuses on a **'One Health' approach** to containing AMR through six key strategic priority areas and multi-sectoral involvement.
- A **Global Action Plan (GAP) on AMR** was developed by the World Health Organization, the Food and Agricultural Organization and the World Organization for Animal Health in 2015.

5. Global Antimicrobial Resistance Research and Development Hub

- **India joins the Global Antimicrobial Resistance Research and Development Hub as a new member.**

About Antimicrobial Resistance (AMR) Research and Development (R&D) Hub:

- Launched in May 2018 in the margins of the 71st session of the World Health Assembly, following a call from G20 Leaders in 2017.
- **Members:** 16 countries, the European Commission, two philanthropic foundations and four international organisations (as observers).
- **Functions:** Supports global priority setting and evidence-based decision-making on the allocation of resources for AMR R&D through the identification of gaps, overlaps and potential for cross-sectoral collaboration and leveraging in AMR R&D.
- **Secretariat:** established in Berlin.
- **Finance:** through grants from the German Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Health (BMG).

Benefits of this partnership for India:

- Opportunity to work with all partners to leverage their existing capabilities, resources and collectively focus on new R&D intervention to address drug resistant infections.

6. Organoids

Organoids are **a group of cells grown in laboratories into three-dimensional, miniature structures that mimic the cell arrangement of a fully-grown organ.**

- They are **tiny (typically the size of a pea) organ-like structures that do not achieve all the functional maturity of human organs but often resemble the early stages of a developing tissue.**
- Most organoids **contain only a subset of all the cells seen in a real organ, but lack blood vessels to make them fully functional.**

How are organoids grown in the laboratory?

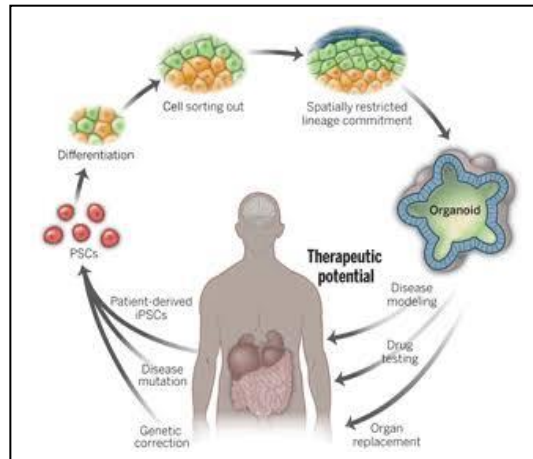
Grown in the lab **using stem cells** that can become any of the specialised cells seen in the human body, or stem cells taken from the organ or adults cells that have been induced to behave like stem cells, scientifically called **induced pluripotent stem cells (iPSC).**

Organoids of the brain, small intestine, kidney, heart, stomach, eyes, liver, pancreas, prostate, salivary glands, and inner ear to name a few have already been developed in the laboratory.

How have organoids helped in our understanding of diseases?

- Organoids offer new opportunities to studying **proteins and genes that are critical for the development of an organ.** This helps in knowing how a mutation in a specific gene causes a disease or disorder.

- For example, Researchers have used **brain organoids to study how the Zika virus affects brain development in the embryo.**
- Since the organoids **closely resemble mature tissues, it opens up new vistas.** These include **studying the complex arrangements of cells in three-dimension and their function in detail, and understanding how cells assemble into organs.**
- Organoids can be used to study **the safety and efficacy of new drugs and also test the response of tissues to existing medicines.**
- Organoids will bring **precision medicine closer to reality** by developing patient-specific treatment strategies by studying which drugs the patient is most sensitive to.



7. CRISPR TECHNOLOGY

- **CRISPR anti-venom:** Antidote to world's most venomous sting made with gene editing.
- **Chironex fleckeri** is among the deadliest box jellyfish species, with an explosive sting that causes cardiac arrest in humans. A team of researchers has managed to develop an antidote to block its venom using the powerful gene-editing tool CRISPR. The drug, **cyclodextrin**, is already tested safe for humans, cheap and readily available.

What is CRISPR-Cas9?

- The **clustered, regularly interspaced, short palindromic repeats**, or CRISPR/CRISPR-associated protein 9 (Cas9) (CRISPR-Cas9) system has revolutionised genetic manipulations and made gene editing simpler, faster and easily accessible to most laboratories.
- CRISPR technology is basically a **gene-editing technology** that can be used for the purpose of altering genetic expression or changing the genome of an organism.
- The technology can be used for targeting specific stretches of an entire genetic code or editing the DNA at particular locations.
- CRISPR technology is a simple yet powerful tool for editing genomes. It allows researchers to easily alter DNA sequences and modify gene function.
- Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops. However, its promise also raises ethical concerns.

How it works?

- CRISPR-Cas9 technology behaves like a **cut-and-paste mechanism on DNA strands** that contain genetic information.
- The specific location of the genetic codes that need to be changed, or "edited", is identified on the DNA strand, and then, using the Cas9 protein, which acts like a pair of scissors, that location is cut off from the strand. A DNA strand, when broken, has a natural tendency to repair itself.
- Scientists intervene during this auto-repair process, supplying the desired sequence of genetic codes that binds itself with the broken DNA strand.

What are Genes and what is gene-editing?

- Genes contain the bio-information that defines any individual. Physical attributes like height, skin or hair colour, more subtle features and even behavioural traits can be attributed to information encoded in the genetic material.
- An ability to alter this information gives scientists the power to control some of these features. **Gene "editing"** — sometimes expressed in related, but not always equivalent, terms like genetic modification, genetic manipulation or genetic engineering — is not new.

Events / Celebrations

1. National Science Day

28th February is celebrated as National Science Day (NSD) in India. NSD is celebrated to commemorate discovery of the '**Raman Effect**', which led to Sir C.V. Raman winning the Noble Prize.

The **first National Science Day** was celebrated on February 28, 1987.

Theme:

The theme for National Science Day 2020 is "**Women in Science**", which aims to appreciate the contribution of women in the field of science.

What is Raman Effect?

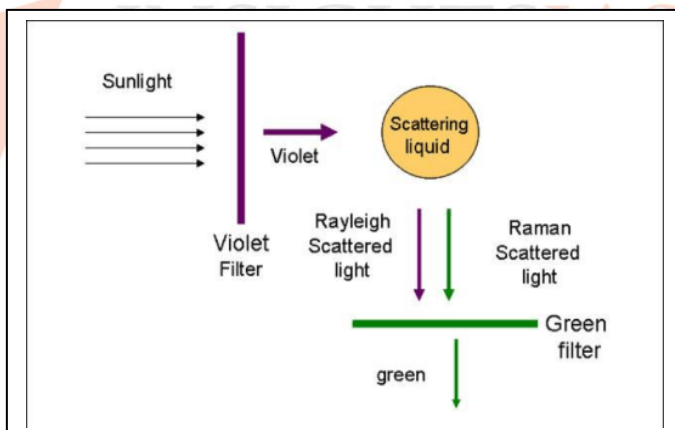
A phenomenon in spectroscopy discovered by the eminent physicist Sir Chandrasekhara Venkata Raman in 1928.

Raman Effect is **a change in the wavelength of light that occurs when a light beam is deflected by molecules.**

- When a beam of light traverses a dust-free, transparent sample of a chemical compound, a small fraction of the light emerges in directions other than that of the incident (incoming) beam.
- Most of this scattered light is of unchanged wavelength. A small part, however, has wavelengths different from that of the incident light; its presence is a result of the Raman Effect.

Raman's experiment:

The violet light of the solar spectrum is isolated with a violet filter and passed through the liquid sample. Most of the light emerging from the liquid sample is the same color as the incident violet beam: the so-called Rayleigh scattered light (the scattering of light by particles in a medium, without change in wavelength. It accounts, for example, for the blue colour of the sky, since blue light is scattered slightly more efficiently than red).



However, Raman, along with K S Krishnan was able to show that **some of the scattered light was a different color, which they could isolate by using a green filter placed between the observer and the sample.**

2. Indian Science Congress

107th Indian Science Congress was held at **the University of Agricultural Sciences (UAS) in Bengaluru, Karnataka.**

Theme: "Science & Technology: Rural Development".

Background:

Indian Science Congress is organised by **the Indian Science Congress Association** every year in the first week of January.

About Indian Science Congress Association:

The Indian Science Congress Association was **started in the year 1914 in Kolkata and has a membership of more than 30,000 scientists.**

Origin: It owes its origin to the foresight and initiative of **two British chemists, namely, Professor J. L. Simonsen and Professor P. S. MacMahon.** It occurred to them that scientific research in India might be stimulated if an annual meeting of research workers somewhat on the lines of the British Association for the Advancement of Science could be arranged.

Objectives:

- To advance and promote the cause of science in India.
- To hold an annual congress at a suitable place in India.
- To publish such proceedings, journals, transactions and other publications as may be considered desirable.
- To secure and manage funds and endowments for the promotion of Science including the rights of disposing of or selling all or any portion of the properties of the Association.
- To do and perform any or all other acts, matters and things as are conducive to, or incidental to, or necessary for, the above objects.

3. National Mathematics Day 2019

National Mathematics Day is **celebrated every year on December 22.**

It is **observed to honor the birth anniversary of the famous mathematician Srinivasa Ramanujan** who greatly contributed towards mathematical analysis, number theory, infinite series and continued fractions.

National Mathematics Day:

In 2012, **the Indian Government declared that 22 December will be celebrated every year as National Mathematics Day.**

Highlights of Srinivasa Ramanujan's life:

- In 1911, Ramanujan published the first of his papers in the Journal of the **Indian Mathematical Society.**
- Ramanujan traveled to England in 1914, where Hardy tutored him and collaborated with him in some research.
- He worked out the **Riemann series, the elliptic integrals, hypergeometric series, the functional equations of the zeta function, and his own theory of divergent series.**
- The number **1729 is known as the Hardy-Ramanujan number** after a famous visit by Hardy to see Ramanujan at a hospital.
- Hardy observed Ramanujan's work primarily involved fields less known even amongst other pure mathematicians.
- Ramanujan's home state of Tamil Nadu celebrates 22 December as '**State IT Day**', memorialising both the man and his achievements, as a native of Tamil Nadu.

The Dev Patel-starrer '**The Man Who Knew Infinity**' (2015) was a biopic on the mathematician.

4. Ramanujan Machine

- Scientists from Technion — Israel Institute of Technology have developed a concept they have named the **Ramanujan Machine**, after the Indian mathematician.

What is it?

- **It is not really a machine but an algorithm**, and performs a very unconventional function.

What it does?

- The Ramanujan machine is more of a concept than an actual machine—**it exists as a network of computers running algorithms dedicated to finding conjectures about fundamental**

constants in the form of continued fractions—these are defined as fractions of infinite length where the denominator is a certain quantity plus a fraction, where a latter fraction has a similar denominator, etc.)

- **The purpose of the machine is to come up with conjectures** (in the form of mathematical formulas) that humans can analyze, and hopefully prove to be true mathematically.

Why Ramanujan?

- The algorithm reflects the way Srinivasa Ramanujan worked during his brief life (1887-1920). With very little formal training, he engaged with the most celebrated mathematicians of the time, particularly during his stay in England (1914-19), where he eventually became a **Fellow of the Royal Society and earned a research degree from Cambridge**.
- Throughout his life, **Ramanujan came up with novel equations and identities —including equations leading to the value of pi** — and it was usually left to formally trained mathematicians to prove these.

5. National Children’s Science Congress (NCSC)

The latest edition of **National Children’s Science Congress was held in Thiruvananthapuram**.

Theme: “Science, Technology and Innovation for a Clean, Green and Healthy Nation”.

National Children’s Science Congress (NCSC):

It is **a nationwide Science Communication programme** started in the year 1993.

It is a **programme of National Council for Science and Technology Communication (NCSTC)**, Department of Science and Technology, New Delhi.

It is **a forum children of the age-group of 10-17 years**, both **from formal school system as well as from out of school**, to exhibit their creativity and innovativeness and more particularly their ability to solve a societal problem experienced locally using by method of science.

About National Council for Science and Technology Communication (NCSTC):

It is mandated to communicate science & technology to masses.

- It is a registered body guided by a Board of Governors with headquarters at Delhi.
- It has about eighty members spread in all states and union territories.
- Volunteers in districts lend it great strength and capability for implementing projects that reach the common man and woman.

Miscellaneous

1. Purified Terephthalic Acid (PTA)

- The government abolished in “public interest” an anti-dumping duty that was levied on imports of a chemical called **PTA**.

What is PTA?

- Purified Terephthalic Acid (PTA) is a crucial raw material used to make various products, including polyester fabrics.
- PTA makes up for around 70-80% of a **polyester product** and is, therefore, important to those involved in the manufacture of man-made fabrics or their components.
- This includes products like polyester staple fibre and spun yarn. Some sportswear, swimsuits, dresses, trousers, curtains, sofa covers, jackets, car seat covers and bed sheets have a certain proportion of polyester in them.

2. Yellow Rust

Yellow Rust was recently *detected in wheat crops in parts of Punjab and Haryana*.

What is Yellow Rust?

It is a disease that appears as yellow stripes of powder or dust on leaves and leaf sheaths of the wheat crop.

How it occurs?

This occurs when the rust colonies in the leaves drain the carbohydrates from the plant and reduce the green leaf area.

Rain, dew and fog favour the disease's development.



Spread:

The disease **can spread rapidly under congenial conditions and affects crop development, and eventually the yield.**

Yield due to the disease can be affected by between 5 and 30 per cent.

Where else is it observed in India?

In India, it is a major disease in the Northern Hill Zone and the North-Western Plain Zone and spreads easily during the onset of cool weather and when wind conditions are favourable.

Disease management:

Breeding resistant varieties is the most cost-effective method to control this rust.

These resistance genes, however, have become ineffective due to the acquisition of virulence to that particular resistance gene rendering the variety susceptible.

3. Locust attacks

Recently there were major locust attacks observed in several **countries in western and southern Asia and in eastern Africa**.

Locusts are a collection of certain species of **short-horned grasshoppers** in the family Acrididae that have a swarming phase. These insects are **usually solitary, but under certain circumstances they become more abundant and change their behaviour and habits, becoming gregarious**.

The **locust**, a short-horned, desert grasshopper that **attacks standing crops and green vegetation**, has been making news in India since May-June 2019, when it appeared in Rajasthan and Gujarat. In Kharif season (June to October) last year, it was also seen in a few areas along Punjab's border with Rajasthan.



Four species of locusts are found in India: Desert locust (*Schistocerca gregaria*), Migratory locust (*Locusta migratoria*), Bombay Locust (*Nomadacris succincta*) and Tree locust (*Anacridium* sp.).

How do they inflict damage?

- The swarms devour leaves, flowers, fruits, seeds, bark and growing points, and also destroy plants by their sheer weight as they descend on them in massive numbers.
- The **desert locust is regarded as the most destructive pest in India** as well as internationally, with a small swarm covering one square kilometre being able to consume the same amount of food in one day as 35,000 people.

4. Zero Budget Natural Farming (ZBNF)

It is **a method of farming where the cost of growing and harvesting plants is zero.**

This means that **farmers need not purchase fertilizers and pesticides in order to ensure the healthy growth of crops.**

It is, basically, **a natural farming technique that uses biological pesticides** instead of chemical-based fertilizers.

- Farmers use earthworms, cow dung, urine, plants, human excreta and such biological fertilizers for crop protection. It reduces farmers' investment. It also protects the soil from degradation.

Benefits of Zero Budget Natural Farming (ZBNF):

1. As both a social and environmental programme, it aims to ensure that **farming – particularly smallholder farming – is economically viable by enhancing farm biodiversity and ecosystem services.**
2. It **reduces farmers' costs** through eliminating external inputs and using in-situ resources to rejuvenate soils, whilst simultaneously increasing incomes, and restoring ecosystem health through diverse, multi-layered cropping systems.
3. **Cow dung from local cows has proven to be a miraculous cure to revive the fertility and nutrient value of soil.**
4. **Zero budget natural farming requires only 10 per cent water and 10 per cent electricity** than what is required under chemical and organic farming. ZBNF may improve the potential of crops to adapt to and be produced for evolving climatic conditions.

Four wheels of ZBNF to be implemented in practically:

The "four wheels" of ZBNF are '**Jiwamrita**', '**Bijamrita**', '**Mulching**' and '**Waaphasa**', says Palekar, a Padma Shri awardee.

- **Jiwamrita** is a fermented mixture of cow dung and urine (of desi breeds), jaggery, pulses flour, water and soil from the farm bund. This isn't a fertiliser, but just a source of some 500 crore micro-organisms that can convert all the necessary "non-available" nutrients into "available" form.
- **Bijamrita** is a mix of desi cow dung and urine, water, bund soil and lime that is used as a seed treatment solution prior to sowing.
- **Mulching**, or covering the plants with a layer of dried straw or fallen leaves, is meant to conserve soil moisture and keep the temperature around the roots at 25-32 degrees Celsius, which allows the microorganisms to do their job.

- **Waaphasa**, or providing water to maintain the required moisture-air balance, also achieves the same objective.

Government initiatives to support ZBNF:

Government of India has been promoting organic farming in the country through the dedicated schemes of **Paramparagat Krishi Vikas Yojana (PKVY)** since 2015-16 and also through **Rashtriya Krishi Vikas Yojana (RKVY)**.

- In the revised guidelines of **PKVY scheme** during the year 2018, various organic farming models like Natural Farming, Rishi Farming, Vedic Farming, Cow Farming, Homa Farming, Zero Budget Natural Farming (ZBNF) etc. have been included wherein flexibility is given to states to adopt any model of Organic Farming including ZBNF depending on farmer's choice.
- Under the **RKVY scheme**, organic farming/ natural farming project components are considered by the respective State Level Sanctioning Committee (SLSC) according to their priority/ choice.

5. Vikram Sarabhai

Indian Space Research Organisation (ISRO) and Department of Atomic Energy (DAE) conducted various events at national level in a yearlong programme to commemorate **the 100th birth anniversary of Dr. Vikram Sarabhai**.

About Vikram Sarabhai and his contributions:

Vikram Sarabhai was born on August 12, 1919. Sarabhai was instrumental in forming India's future in astronomy and setting up the country's space research facilities.

Key contributions:

- Based on his persuasion, the Indian government agreed to set up the Indian National Committee for Space Research (**INCOSPAR**) in 1962.
- Sarabhai was the first chairman of the committee. The INCOSPAR was restructured and renamed as **Indian Space Research Organisation (ISRO) in 1969**.
- Sarabhai founded **the Physical Research Laboratory in Ahmedabad in the year 1947**. The laboratory started its operation from RETREAT, Sarabhai's residence in Ahmedabad. Its first topic of research was cosmic rays.
- He also set up **India's first rocket launch site in Thumba**, a small village near the Thiruvananthapuram airport in Kerala.
- Vikram Sarabhai was also responsible for **bringing cable television to India**. His constant contact with NASA paved a way for the establishment of **Satellite Instructional Television Experiment (SITE) in 1975**.
- Sarabhai was the mastermind behind building **India's first satellite, Aryabhata**.
- He was one of the **founding members of the Indian Institute of Management, Ahmedabad (IIMA)**.
- Vikram Sarabhai received **the Padma Bhushan in 1966** for his contribution to India's progress. He was also awarded **the Padma Vibhushan in 1972, posthumously**.

6. Paris Convention for the Protection of Industrial Property

Khadi Village Industries Corporation is eyeing international trademark for 'khadi' under **the Paris Convention for protection of industrial property**.

Why? To prevent any product from masquerading as 'khadi' nationally or globally.

How is it presently protected?

The Regulations issued in 2013 by the ministry of micro, small and medium enterprises, empower **KVIC to grant 'Khadi Mark' registration and take royalties from any producer using the Khadi**

mark.

About Paris Convention for the Protection of Industrial Property:

It is **a multilateral treaty** dealing with the protection of industrial property in the widest sense.

Administered by the **World Intellectual Property Organization (WIPO)**.

Article 6 of the Paris Convention of 1883 protects armorial bearings, flags and other State symbols of the States part to the convention, including official signs, and hallmarks indicating control and warranty adopted by them.

As of January 2019, **the Convention has 177 contracting member countries**.

7. Rare Earth Elements

The US Army plans to fund the construction of a **Rare Earths processing facility** to secure the domestic supply of minerals that are used to make military weapons and electronics.

This will be **the first financial investment by the US military into commercial-scale Rare Earths production** since the Manhattan Project to build the first atomic bomb during World War II.

What are REMs?

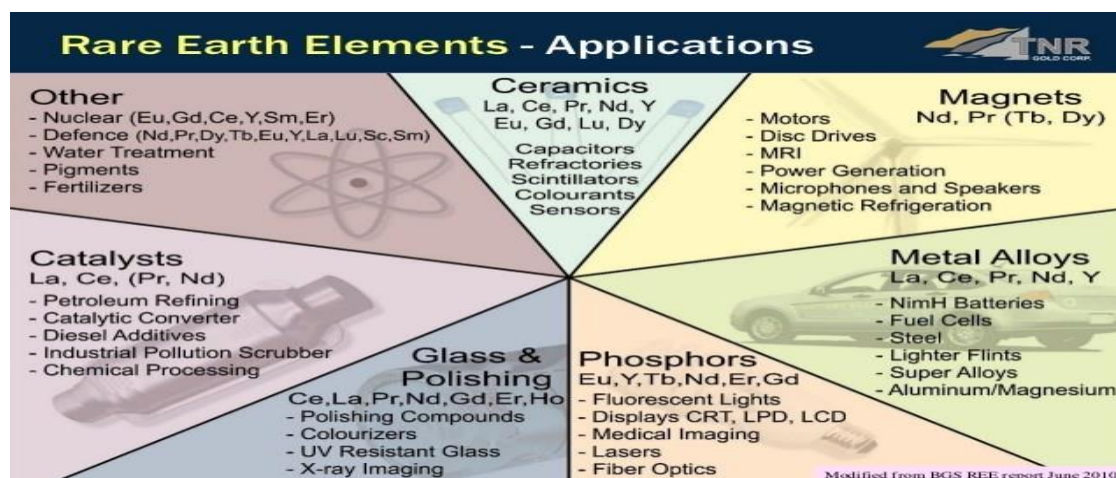
- The rare earths minerals (REM) are a set of seventeen metallic elements. These include the fifteen lanthanides on the periodic table in addition to scandium and yttrium that show similar physical and chemical properties to the lanthanides.
- The REMs have **unique catalytic, metallurgical, nuclear, electrical, magnetic and luminescent properties**. While named 'rare earth', they are in fact not that rare and are relatively abundant in the Earth's crust.

Strategic importance of REMs:

They have distinctive **electrical, metallurgical, catalytic, nuclear, magnetic and luminescent properties**.

- Its usage ranges from daily use (e.g., lighter flints, glass polishing mediums, car alternators) to high-end technology (lasers, magnets, batteries, fibre-optic telecommunication cables).
- Even futuristic technologies need these REMs (For example high-temperature superconductivity, safe storage and transport of hydrogen for a post-hydrocarbon economy, environmental global warming and energy efficiency issues).

Due to their unique magnetic, luminescent, and electrochemical properties, they help in technologies perform with reduced weight, reduced emissions, and energy consumption; therefore, give them greater efficiency, performance, miniaturization, speed, durability



8. Protection of Plant Varieties and Farmers' Rights Authority (PPV&FR)

The Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001:

- Enacted by India in 2001 adopting *sui generis system*.
- It is in conformity with *International Union for the Protection of New Varieties of Plants (UPOV), 1978*.
- The legislation *recognizes the contributions of both commercial plant breeders and farmers in plant breeding activity and also provides to implement TRIPs in a way that supports the specific socio-economic interests of all the stakeholders* including private, public sectors and research institutions, as well as resource-constrained farmers.

Objectives of the PPV & FR Act, 2001:

- To establish an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants.
- To recognize and protect the rights of farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties.
- To accelerate agricultural development in the country, protect plant breeders' rights; stimulate investment for research and development both in public & private sector for the development new of plant varieties.
- Facilitate the growth of seed industry in the country which will ensure the availability of high-quality seeds and planting material to the farmers.

Rights under the Act:

Breeders' Rights: Breeders will have exclusive rights to produce, sell, market, distribute, import or export the protected variety. Breeder can appoint agent/ licensee and may exercise for civil remedy in case of infringement of rights.

Researchers' Rights: Researcher can use any of the registered variety under the Act for conducting experiment or research. This includes the use of a variety as an initial source of variety for the purpose of developing another variety but repeated use needs prior permission of the registered breeder.

Farmers' Rights:

- A farmer who has evolved or developed a new variety is entitled for registration and protection in like manner as a breeder of a variety;
- Farmers variety can also be registered as an extant variety;
- A farmer can save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under the PPV&FR Act, 2001 in the same manner as he was entitled before the coming into force of this Act provided farmer shall not be entitled to sell branded seed of a variety protected under the PPV&FR Act, 2001;
- Farmers are eligible for recognition and rewards for the conservation of Plant Genetic Resources of land races and wild relatives of economic plants;
- There is also a provision for compensation to the farmers for non-performance of variety under Section 39 (2) of the Act, 2001 and
- Farmer shall not be liable to pay any fee in any proceeding before the Authority or Registrar or the Tribunal or the High Court under the Act.

9. StrandHogg

It is a **Malware** which *allows real-time malware applications to pose as genuine applications and access user data of all kinds*.

Threats: It can listen to the conversations, access photo album, read/send messages, make calls, record conversations, get login credentials to various accounts, access private images, files, contact details, call logs and location information without being apparent to the affected users.

Why in News? The Union Home Ministry has alerted States, warning them about the vulnerability of the Android operating system to **a bug called 'StrandHogg'**.

10. Malware

Nuclear Power Corporation of India Ltd. (NPCIL) had confirmed that a malware had infected its system at **the Kudankulam Nuclear Power Plant (KKNPP)**.

It was infected by **DTrack, a North Korean virus**.

What is a Malware?

It is short for "**malicious software**," also known as malicious code or "**malcode**." It is code or software that is **specifically designed to damage, disrupt, steal, or in general inflict some other "bad" or illegitimate action on data, hosts, or networks**.

Some of the more **commonly known types of malware are** viruses, worms, Trojans, bots, ransomware, backdoors, spyware, and adware.

11. Contract for the Web

Sir Tim Berners-Lee, inventor of **the World Wide Web**, has announced a "**Contract for the Web**" — aimed at saving the future of his invention.

What is the Contract for the Web?

The idea is **to create a global plan of action for all stakeholders to together commit to building a "better" Web**. The goal is **to create a standard policy for a Web that benefits all**.

The Contract **consists of nine principles** — three each for governments, private companies, and individuals and civil society to endorse.

It has been created by **representatives from over 80 organisations**, including governments, companies, civil society activists, and academics.

What are the principles in the Contract?

1. **Governments** will "Ensure everyone can connect to the Internet", "Keep all of the Internet available, all of the time", and "Respect and protect people's fundamental online privacy and data rights".
2. **Companies** will "Make the Internet affordable and accessible to everyone", "Respect and protect people's privacy and personal data to build online trust", and "Develop technologies that support the best in humanity and challenge the worst".
3. **Citizens** will "Be creators and collaborators on the Web", "Build strong communities that respect civil discourse and human dignity", and "Fight for the Web" so that it "remains open and a global public resource for people everywhere, now and in the future".

How will the Contract be implemented?

The 'Contract for the Web' is not a legal document, or a United Nations document — though the organisation is in talks with the UN. It cannot currently bend governments or companies — even those that are on board — to its will.

12. NASA Unveils First Electric Plane X-57 "Maxwell"

NASA recently showcased an early version of its **first all-electric experimental aircraft, the X-57 "Maxwell"**.

Adapted from **an Italian-made Tecnam P2006T twin-engine propeller plane**, the X-57 has been under development since 2015.

13. Asbestos in Baby Powder

What is talc, and why is asbestos relevant?

Talc is a mineral in clay mined from underground deposits. It's the softest mineral known to man and that makes it useful in a wide range of consumer and industrial products.

Asbestos is also found underground, and veins of it can often be found in talc deposits, leading to a risk of cross-contamination, geologists say.

About Asbestos:

Asbestos is **a set of six naturally occurring silicate minerals**, which all have in common their eponymous asbestiform habit: i.e., long, thin fibrous crystals, with each visible fiber composed of millions of microscopic “fibrils” that can be released by abrasion and other processes.

They are commonly known by their colors, as blue asbestos, brown asbestos, white asbestos, and green asbestos.

Uses and applications:

- Manufacturers and builders use asbestos for its desirable physical properties. Some of those properties are sound absorption, average tensile strength, affordability, and resistance to fire, heat, and electricity. It was used in such applications as electrical insulation for hotplate wiring and in building insulation.
- When asbestos is used for its resistance to fire or heat, the fibers are often mixed with cement or woven into fabric or mats. These desirable properties led to asbestos being used very widely.

Health effects:

Inhalation of asbestos fibers can cause serious and fatal illnesses including lung cancer, mesothelioma, and asbestosis (a type of pneumoconiosis).

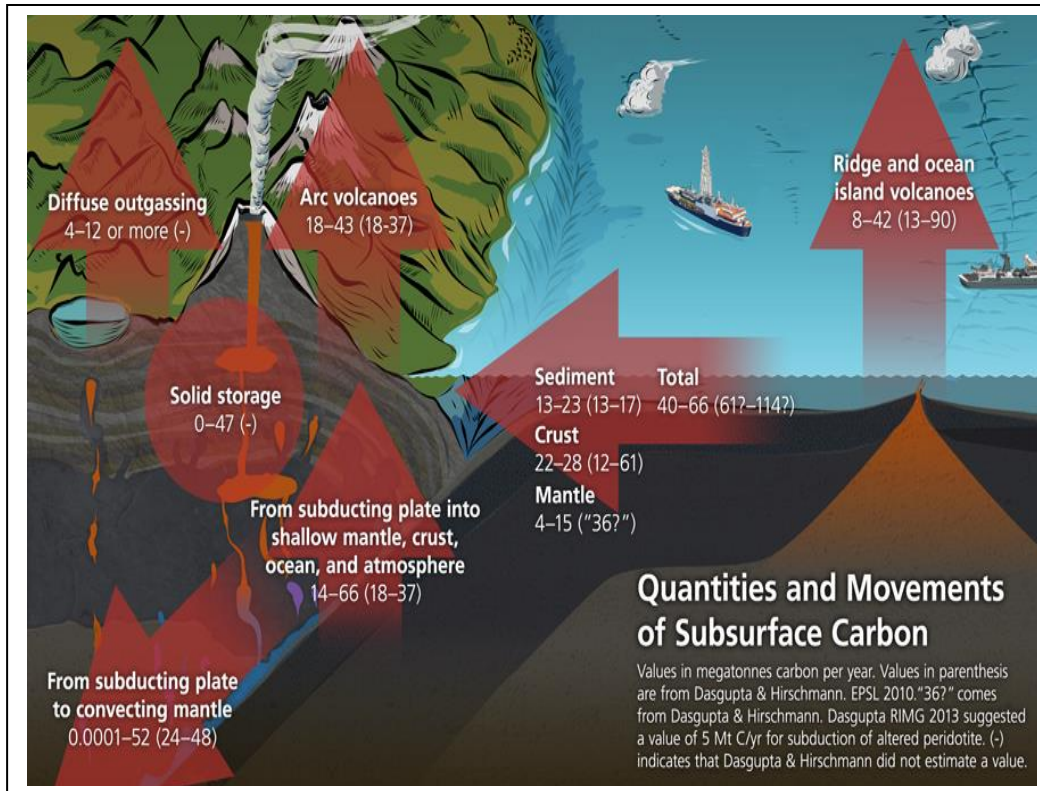
14. Deep Carbon Observatory (CDO)

Deep Carbon Observatory (CDO) has released a report on Carbon, its emissions and availability. The study's results are concerning due to **past extinction events linked to the mass release of atmospheric CO₂**.

Key findings:

- Less than one percent of the planet's carbon is found above surface.
- The rest of the carbon – about 1.85 billion gigatonnes – is trapped in the planet's crust and mantle.
- The carbon that is found in the oceans, the land and the atmosphere, for the most part, appears to be disturbed by human activity.
- Human emissions of the greenhouse gas are 100 times greater than all of Earth's volcanoes.

- Human activity contributes about 10 gigatonnes of CO₂ into the atmosphere each year. Natural geological process underground, for comparison, release about 10 times less of the global warming gas.



About Deep Carbon Observatory (DCO):

It is a global community of more than 1000 scientists on **a ten-year quest** to understand the quantities, movements, forms, and origins of carbon in Earth.

Why study carbon in Earth?

Carbon plays a fundamental role on Earth. It forms the chemical backbone for all essential organic molecules produced by living organisms. Carbon-based fuels supply most of society's energy. Atmospheric carbon dioxide affects Earth's climate. Yet despite its importance, remarkably little is known about the physical, chemical, and biological behaviour of carbon in the vast majority of Earth's interior.

15. Rice Fortification

- To tackle the menace of Malnutrition, NITI Aayog seeks creation of roadmap by Department of Food and Public Distribution for taking **the Rice Fortification Pilot Scheme** Pan India.

What is Rice Fortification?

- Fortification is **the practice of deliberately increasing the content of an essential micronutrient**, i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.
- Rice fortification is the practice of increasing the content of essential micronutrients in rice and to improve the nutritional quality of the rice.

Why Rice Fortification?

- Regular milled rice is low in micronutrients and serves primarily as a source of carbohydrate only. **The fortification of rice is a major opportunity to improve nutrition.**
- Fortified rice contains Vitamin A, Vitamin B1, Vitamin B12, Folic Acid, Iron and Zinc.

Food fortification in India:

- **Food Safety and Standards Authority of India (FSSAI)** has formulated a comprehensive regulation on fortification of foods namely '**Food Safety and Standards (Fortification of Foods) Regulations, 2016**'. These regulations set the standards for food fortification and encourage the production, manufacture, distribution, sale and consumption of fortified foods.
- The regulations also provide for specific role of FSSAI in promotion for food fortification and to make fortification mandatory. This sets the premise for the national summit on fortification of food.

Benefits of fortification:

- If consumed on a regular and frequent basis, fortified foods will maintain body stores of nutrients more efficiently and more effectively than will intermittent supplements.
- Fortified foods are also better at lowering the risk of the multiple deficiencies that can result from seasonal deficits in the food supply or a poor-quality diet.
- Fortification can be an excellent way of increasing the content of vitamins in breast milk and thus reducing the need for supplementation in postpartum women and infants.
- Fortification of widely distributed and widely consumed foods has the potential to improve the nutritional status of a large proportion of the population, both poor and wealthy.
- Fortification is often more cost-effective than other strategies, especially if the technology already exists and if an appropriate food distribution system is in place.

16.SERICIN

- Produced by silkworms, it is a **silk protein** which is known to **possess anti-oxidant and other medicinal properties**.
- These properties depend on amino acid composition and secondary metabolites (polyphenols and flavonoids) of sericin.
- They **vary with source of silkworms and their availability depends on the length of sericin peptides** obtained during extraction.
- **Uses:** It could be used for protection from oxidative damage, edema, erythema, sunburn, premature aging, wrinkling, and skin cancer.

17.SUPERCONDUCTIVITY

- IISc researchers have reported **superconductivity at room temperature**. Their finding, now under review, will be a breakthrough if verified.

Background:

- Superconductivity is a **phenomenon that, so far, has been possible only at extremely low temperatures**, in the range of 100°C below zero. The search for a material that exhibits superconductivity at room temperature, or at least manageable low temperatures, has been going on for decades, without success. If the claimed discovery were confirmed, it could be one of the biggest breakthroughs in physics in this century so far.

What is superconductivity?

- It is a state in which a **material shows absolutely zero electrical resistance**. While resistance is a property that restricts the flow of electricity, superconductivity allows unhindered flow.
- In a superconducting state, the **material offers no resistance at all**. All the electrons align themselves in a particular direction, and move without any obstruction in a "**coherent**" manner.
- Because of zero resistance, **superconducting materials can save huge amounts of energy**, and be used to make highly efficient electrical appliances.

Two fundamental properties of a superconductor:

- Zero resistance to electrical current.
- Diamagnetism

Diamagnetism is a property opposite to normal magnetism that we are used to. A diamagnetic substance repels an external magnetic field, in sharp contrast to normal magnetism, or ferromagnetism, under which a substance is attracted by an external magnetic field.



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